Cartographic Perspectives

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North American Cartographic Information Society

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From the Editor

Dear NACIS Members:

Our unusually dry and warm summer is beginning to wind down here on the side of Big Savage Mountain. Already signs of fall appear across the green mountainside as the leaves of the black locust have already turned brown. It won't be too long until the landscape is dotted with hues of crimson, umber, and gold as other leaves befall their ritualistic demise. I hope your autumn is off to a good start.

This issue of *CP* contains a mixture of cartographic offerings which I hope you will find intriguing. The featured articles highlight experimentation, one a novel approach that integrates technology and the other dealing with cognitive cartography. The first article titled *Investigating Geospatial Holograms for Special Weapons and Tactics Teams* is written by Sven Fuhrmann. His article discusses the possibilities of using holograms as a visualization tool for spatial environments. The second article, titled *Learning of Locations on Maps: Prior Knowledge, Asymmetrical Learning and Sex Diffe - ences,* authored by David Patton and Robert Lloyd, presents results of an experiment that examined the differences between males and females when learning spatial information. This article will surely prompt discussion among those interested in cognitive cartography.

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In this Issue

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Fritz Kessler,
Editor
Department of Geography
Frostburg State University
230 Gunter Hall
101 Braddock Blvd
Frostburg, MD 21532
(301) 687-4266
fax: (301) 687-4495
fkessler@frostburg.edu

(*letter from the editor continued*)

As an added bonus to this issue, you will also find a report summarizing the results of the first *CP* readership survey. In January 2009 an email was sent out to the NACIS membership asking for their participation in a survey on *CP*. The survey's purpose was to determine people's opinions about *CP* and what its future may hold. While the opinions expressed varied considerably, the main thrust of the survey results suggests that *CP* needs to change. Among the types of "change" suggested was a strong opinion that *CP* needs to have an online presence. As you may be aware, the print industry is reeling under the pressure from the Web and other devices that offer access and delivery of information. In some cases, journals have offered a mixture of print and online offerings to its readership. In other cases, journals have done away with the print side completely and deliver its content exclusively online. In some respects, this issue of Web delivery and accessibility has been addressed. A digital archive of older *CP* issues is now freely available to anyone simply by visiting the NACIS Web site. However, there is a two-year embargo on posting current issues. Obviously, more work on merging the print version of *CP* with the digital services that the Web offers has yet to occur. Another strong sentiment expressed by the survey respondents was to change the contents of *CP*. Some wanted more topics that focused on the technical aspects or "hands-on" of using software to make maps. Others wanted to simply see more maps in the journal. Time and more discussion will be needed to decide how best to implement these and other changes voiced in the survey results.

Aside from these issues, one overriding problem remains: submissions. As of this writing, *CP* has received two (2) articles since the start of 2009. At this current pace, *CP*'s publication schedule is going to lag, and the vitality of the journal will surely falter. The readership survey did address the issue of submissions to *CP* and the responses did prove to be a mixed bag of sorts. On the one hand, the survey reported that a high percentage of respondents would consider submitting something to *CP* for potential publication. However, only one-third of the respondents have, in fact, submitted something to *CP* for publication consideration. It is clear that the bulk of submissions to the journal do not necessarily come from the readership. The question remains: What is needed to increase submissions? Will changing *CP*'s content to reflect the interests of the journal's readership result in a renewed submission vigor? If *CP* can better integrate with the Web, will this ensure the journal's vitality? It is likely that none of these singular approaches will be the cure-all. Rather, it is more probable that some combination of these solutions and other possibilities will restore the long-term health of the journal.

If you are interested in the health and longevity of *CP,* I encourage you to attend a special panel session at this year's NACIS conference. The issues brought out by the readership survey and what to do about them will serve as a backdrop to this discussion to be held during the upcoming conference in Sacramento, California. I hope you will consider sitting in on the discussion session and offer your thoughts and ideas on ways in which *CP* will be kept healthy while meeting the needs of the journal's readership.

The individual sections follow. You will find two offerings inside the Cartographic Collections section. The first is by Martin

(*continued on page 4*)

The Cover

Measure in Mutiny

1994**,** 60 ″ x 80″, oil and acrylic/canvas
Susanne Slavick
Andrew W. Mellon Professor of Art
Carnegie Mellon University

Measure in Mutiny is from a series of paintings inspired by antiquated maps. Acknowledging the inescapable distortions of mapping, both technological and ideological, I jettisoned the information offered by my source map and filled its remaining shape with a geography of my own invention. Directional winds are often represented in early maps by fat-cheeked cherubs blowing every which way. Here they are replaced with black lungs or balloons with protruding ribboned tongues. Perhaps they mirror the miasma of a polluted world or mock the very idea of measuring such a complex entity.
http://artscool.cfa.cmu.edu/~slavick/

(*letter from the editor continued*)

Woods who offers an article titled *The Maps Collection of the National Library of Australia*. In his article, he discusses the history of the Maps Collection and the wide range of technological services it provides its users today. The second article titled *The University of Georgia Libraries Map Library* is by Hallie Pritchett. She presents an overview of the range of print and digital map services provided by the library and staff. The Mapping Methods and Tips section includes an interesting piece from Daniel Huffman titled *A Technique for Encoding Elevation Changes Along a Route*. The article discusses a novel approach for symbolizing changes in elevation along a road. He argues that most road maps bicyclists use do not show changes in grade, and this information is especially important when choosing a route to follow. The Visual Fields piece presents a series of maps created by Molly Holmberg. She is a freelance cartographer residing in Bangor, Maine, whose craft is exclusively hand-drawn maps***. A sampling of her cartographic creations fills this issue's offering of Visual Fields.***

I encourage each of you to consider *CP* as the publication outlet for your peer-reviewed papers, opinion pieces, information on map libraries, mapping methods and techniques, and visual fields. I know there is much that is happening in the mapping world out there. *CP* and its readership would like to hear about it.

I offer this issue to you for your contemplation and reading pleasure. I welcome your questions, comments, and discrepancies.

Investigating Geospatial Holograms for Special Weapons and Tactics Teams

Sven Fuhrmann
(corresponding author)
Nevada J. Smith
Department of Geography
Texas State University
fuhrmann@txstate.edu
smith.nevada@gmail.com

Mark Holzbach
Zebra Imaging
Austin, TX
mholzbach@zebraimaging.com

Terry Nichols
San Marcos Police Dept.
TNichols@sanmarcostx.gov

Special Weapons and Tactics (SWAT) teams rely heavily on collecting and applying geospatial intelligence. Traditional two-dimensional mapping products might limit or hinder successful operations by not showing important three-dimensional information of the terrain and its natural and/or human-built objects. Geospatial holograms are able to display these three dimensional spatial features to users without requiring special eyewear or using complex viewing technologies. A point light source is all that is required to make the imagery visible. Before introducing geospatial holograms into the SWAT domain, where lives are at potential risk, a series of usefulness, acceptance, and usability tests need to be performed. One of the key geospatial hologram design requirements identified for SWAT incidents was support for effective route planning and wayfinding. This paper will report about a first pilot study that investigated and compared wayfinding performance of SWAT teams using both traditional 2D imagery and geospatial holograms. Our initial research indicates that geospatial holograms could enhance SWAT operations, especially in multi-story environments. In the pilot study geospatial holograms were positively reviewed by SWAT team members and were described as a technology that should be further explored.

Keywords: Geovisualization, Geospatial Holograms, Special Weapons and Tactics, Spatial Cognition, Usability

INTRODUCTION

Current domestic and international terrorism threats increase the demand for developing usable and useful tactical geovisualization tools for implementation with Special Weapons and Tactics (SWAT) teams. SWAT teams are responsible for handling high-risk tactical situations, e.g. hostage situations or barricaded suspects. Their primary operational goal is the successful resolution of these situations without injury or loss of life to citizens, suspects, or law enforcement officers (Cappel 1979). Depending on the incident, tactical decisions in SWAT situations mostly rely on experience, education, and geospatial intelligence gathered through observations, the use of aerial photography, and analog or digital maps. The goal of tactical decision making in SWAT situations is to combine analytical and sometimes intuitive solutions, arrive at an appropriate decision, and successfully accomplish a mission (Heal 2006; Bailey 2006; Jones 1996). Digital mapping services, such as Mapquest, Google Maps, Google Earth, and Microsoft Virtual Earth, increasingly serve as analytical tools in planning and managing SWAT incidents. The usage of Web-mapping

Initial submission, July 2008; final acceptance April 2009.

tools within the SWAT domain indicates that first responders and decision makers consider these Web-mapping services highly valuable for many aspects of incident management. These Web-mapping services offer many improvements over traditional paper maps: (1) the datasets are detailed and almost up to date (depending on the service subscription), (2) the technology allows combining topographic information with aerial photography on the fly, (3) the basic mapping service is free, and (4) the graphical user interfaces are relatively easy to use. Recently, with the release of Google Earth and Microsoft Virtual Earth, Web-mapping has become also three-dimensional, i.e. it allows perspective terrain visualization including buildings and other landmarks. These are important features for SWAT incident planning and response, but it must be noted that the current three-dimensional Web mapping technologies in combination with a standard computer monitor offer only a flat two-dimensional view of the three-dimensional models and not a fully realistic three-dimensional visualization.

"Two and three-dimensional Web-mapping techniques could become a standard for managing many crisis situations."

Two and three-dimensional Web-mapping techniques could become a standard for managing many crisis situations. However, one must realize that Web-mapping services also provide numerous shortcomings and potential pitfalls. Web-mapping technologies might work fine during certain crisis situations, such as train derailments, large forest fires, warrant services, etc., but might face serious shortcomings if their base technologies such as electric power and/or computer networks fail. Small screen displays of laptops and/or desktops do not fully support the collaboration between law enforcement officers and/or decision makers. User interfaces of Web mapping applications are language-dependent and/or literacy-dependent and could hinder the communication in a hostage situation, such as between released hostages and law enforcement officers. Especially in high-stress and high-anxiety situations (high school shootings or hostage incidents, for example), first responders, decision makers, and other entities involved need technologies at their disposal that allow them to generate intelligent tactics and support the creation of a common operational picture. These shortcomings of today's Web-mapping services guided the exploration and development of geospatial holograms for tactical geovisualization in SWAT operations.

GEOVISUALIZATION REQUIREMENTS DURING SWAT OPERATIONS

". . . key requirements for geospatial hologram design are that it supports tactical planning, collaboration, and response at a moment's notice and helps build an instant common operational picture."

Snow (1996) explains that the most efficient tactical plan in SWAT operations must be kept simple and flexible so that it can be updated and changed at any minute. Thus, key requirements for geospatial hologram design are that it supports tactical planning, collaboration, and response at a moment's notice and helps build an instant common operational picture. Before a SWAT team responds to an incident with or without force, it collects geospatial intelligence. Geospatial intelligence (GEOINT) is a fairly new field and is broadly defined by the National Geospatial-Intelligence Agency as "the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence, and geospatial information" (National Geospatial-Intelligence Agency 2008: 3). SWAT teams rely heavily on geospatial intelligence, less on remotely sensed data, because of the operational extent, but during their terrain analysis SWAT teams evaluate which features or locations (ranging from large buildings, towers, and hills to much smaller elements such as ditches, ventilation systems, and windows) will provide the suspect and the law enforcement officers with tactical advantages and disadvantages (O'Sullivan 1991; Heal 2006).

In the SWAT context, terrain analysis does not have the classical GI-Science meaning of using remote sensing and elevation information to determine the morphology of a landscape or the influence of topography on environmental processes. Terrain analysis is the collection, analysis, evaluation, and interpretation of geographic information on the natural and man-made elements of the operation area to predict the effect of the terrain on SWAT operations. SWAT terrain analysis often includes an "eyes-on" assessment (Kolman 1982; Bolz, Dudonis, and Schulz 2002) to determine the line of sight and the potential fields of fire, i.e. the potential areas that can be covered with a weapon from one position (Mijares, McCarthy, and Perkins 2000). Once the potential fields of fire are determined, SWAT members usually try to determine cover, concealment, obstacles, and barriers (Grindle et al. 2004). The SWAT team usually tries to determine which obstacles and barriers might work in favor of law enforcement operations, since these objects might also block potential escape routes for the suspects (Bolz, Dudonis, and Schulz 2002). Barriers might not always have negative properties in SWAT operations, e.g. barriers such as a storm drain might hinder direct crossing, but could function as cover. The last step in the terrain analysis determines the routes of approach and escape. This task is often accomplished by the use of air photos and helicopter observations (Office of the Inspector General 2006; Heal 2006). The approach routes must provide concealment and/or cover and contain no barriers and fewer obstacles, while the potential escape routes should be covered by the field of fire. Thus, another key requirement for geospatial hologram design for SWAT incidents is to support effective route planning, spatial learning, and wayfinding.

". . . another key requirement for geospatial hologram design for SWAT incidents is to support effective route planning, spatial learning, and wayfinding."

Tactical mapping, the use of maps or other forms of spatial representations for defining action plans and mission strategies, during fast-paced SWAT incidents is usually done (given the dynamic nature of the events) on car hoods, police car doors, paper scraps (e.g., napkins), and whiteboards, and more recently with Geographic Information Systems (GIS) and online mapping tools (Greene 2002; Sorensen 1998; Leipnik and Albert 2002; Wang 2005). However, these tactical geovisualizations cannot fully represent the three-dimensionality of the surrounding environment (which, as in most SWAT incidents, is within urban boundaries). Heal (2006) lists as one critical factor for urban operations the three-dimensionality of the urban landscape, i.e. multistory houses, towers, bridges, and drainage ditches, which often provide disadvantages for SWAT operations, i.e. close shooting ranges, potential ambushes, communication breakdowns, and the presence of civilians in close by residences. Thus, tactical mapping is required at several scales. Small scale representations of incident sites usually require aerial still photographs and videos taken by a helicopter. The main goals for the small scale terrain mapping are to a) document the built environment, b) set the inner and outer perimeters of the incident site, and c) determine tactical advantages and disadvantages (Snow 1996; Jones 2001). Geospatial intelligence is also collected at larger scale: Floor plans and sketches are obtained of the incident site and the adjacent buildings. Residents and/or employees are questioned for information about the building structure, hallways, doors, and windows. Typical large-scale information also includes details such as door structures, door swing directions, the location of light switches, and the type of lighting (Jones 2001). Thus, another key requirement for geospatial hologram design for SWAT incidents is to support multi-scale representation for tactical planning, wayfinding, and decision making.

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HOLOGRAMS

The Greek-based term *hologram,* meaning "whole or complete writing," describes very well that holograms contain full optical information, allowing the three-dimensional storage and representation of objects and scenes (Kasper and Feller 2001; Hariharan 2002). Holograms were first conceived of in the late 1940s by Dennis Gabor and have ever since been an object of and for scientific research and public interest (Heckman 1986). Over the last several decades holograms have been often associated with visualizing three-dimensional objects for entertainment and eye-catching purposes in amusement parks, commercial product presentations, and art/conference exhibitions and as anti-counterfeit additions to credentials such as credit cards, software license documents, and convention badges (Figure 1).

"Holograms are instantiations of a class of technologies that utilize the physics of light diffraction to transform or manipulate light."

Holograms are instantiations of a class of technologies that utilize the physics of light diffraction to transform or manipulate light. Many of these technologies have the ability to create optical illusions of solid three-dimensional objects or scenes (Kasper and Feller 2001; Hariharan 2002). Photographs usually record the light waves (brightness and color) that are reflected from an object or a scene, while holograms record both a reference light wave (i.e. a laser beam) and the amplitude of reflected light waves from an object or scene. These two reference and object beams are creating an interference pattern which is recorded on the holograms. When correctly illuminated, holographic interference patterns are decoded by the human physiological system, and a realistic three-dimensional scene appears before the human eye (Kasper and Feller 2001; Hariharan 2002; Heckman 1986).

The technology applied in this research utilizes a digital version of holographic technology that is growing out of the Massachusetts Institute of Technology (MIT) Media Laboratory research. The technology is capable of accurately depicting digital three-dimensional structural and terrain information recorded on flat or flexible plastic panels of laminated photopolymer film with full-parallax (i.e., both vertical and horizontal parallax). Users can view these holograms without special glasses, goggles, or tethered eyewear. Only a single point light source, i.e. unobstructed sunlight, a standard LED flashlight, or a standard halogen light, is required to make the imagery visible. Compared to previous versions these holograms are lightweight and use very little space (Figure 2).

"The technology is capable of accurately depicting digital three-dimensional structural and terrain information . . ."

These "modern" holograms differ from traditional holograms. Previously, holograms required as input physical objects on the scale of the recording material and could not easily be tiled together to form larger displays. Nowadays, a number of commercially available three-dimensional digital scanning technologies, e.g. NextEngine's 3D scanner or ATOS by Capture 3D can be used to generate source input data for holograms. Most 3D scanners collect three-dimensional surface information through light, ultrasound, or x-ray and digitally reconstruct these objects as three-dimensional models. While the 3D scanner technology mostly works for smaller objects (although examples for larger objects include commercial airplanes), scanning urban spaces or natural landscapes with these devices is not feasible. For small-scale representations, e.g. urban terrain or a university campus, digital models have to be developed through three-dimensional modeling software, e.g. Google SketchUp, Autodesk Maya, or ArcView 3D Analyst. Nowadays, these digital three-dimensional models replace the old analog models, and the interference patterns are no longer physically recorded (through an actual laser beam), but created through a computational model in which a virtual camera provides the potential viewpoints and interference patterns. In theory, holograms can be created

Figure1. Hologram of the Texas State University campus.

from any digital three-dimensional geospatial model or scene. In the last decade, the production times for holograms have decreased from several days to several hours; thus the designer of these digital model-based holograms just needs to decide which geospatial objects and patterns to include in the final product.

In comparison to traditional analog maps or photos and dynamic two-dimensional electronic displays, the holograms have a low (1 mm) resolution on the surface, but offer a far higher information content because of their directional resolution. Two-dimensional media, such as photographs or maps, display the same information regardless of the viewing angle while holograms can display different spatial information according to the viewing angle of the user. Modern holograms can actually encode spa-

"In the last decade, the production times for holograms have decreased from several days to several hours . . ."

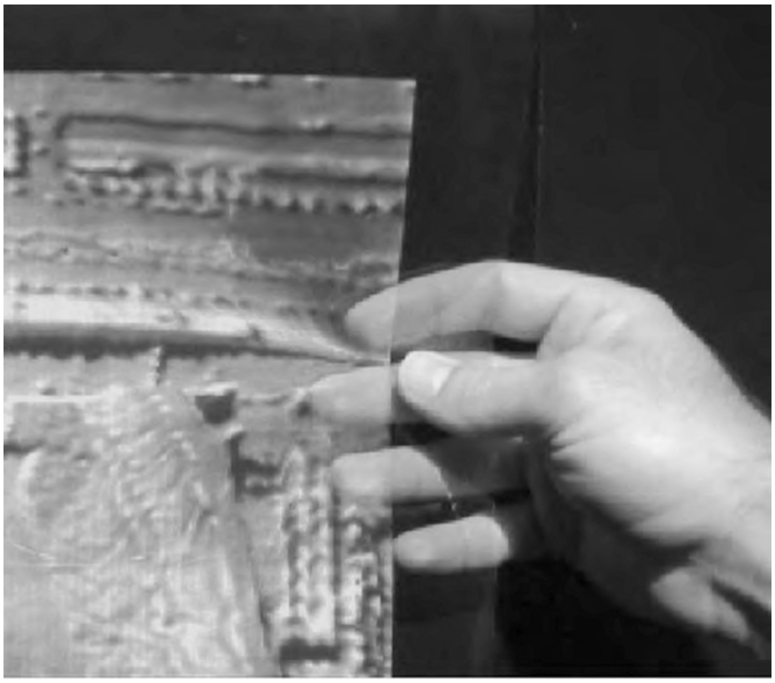

Figure 2. Digital holograms recorded on photopolymer film.

"Before introducing geospatial holograms into a domain where lives are at high risk, a series of usefulness, acceptance, and usability tests need to be performed."

tial information for over one million different viewing angles. Although visualizing one million angles is not practical for a human viewer; this large data storage capacity is required for creating a display that can create and control such a powerful illusion. A one-foot-square map printed at 600 dots per inch with 16.7 million different colors (24-bit = 3 bytes) contains about 156 MB of information (7200 dots * 7200 dots = 51.8 million dots multiplied by 3 bytes) whereas a one-foot-square hologram printed at 25.4 holographic elements (hogels) per inch with the same number of colors contains about 365 GB of information (1 hogel containing 1280x1024 pixels with 24-bit colors results in 3.9 MB/hogel; one square feet of hogels (93025 hogels) results in approximately 365 GB). Since the information in the hologram can be controlled according to viewing direction, entirely different data sets (e.g., variable 3D models or multi-scaled scenes and objects) can be presented at different angles. Benton and Bove (2008) provide a further outlook of different holographic technologies and describe optical computing, metrology, microscopy, and non-destructive testing as important holographic application areas that go far beyond "traditional" display holography. The holy grail, however, in three-dimensional display technology is a dynamically updatable hologram, a challenge that might be solved in the coming years (Benton and Bove 2008).

INVESTIGATING WAYFINDING PERFORMANCE AND ACCEPTANCE OF GEOSPATIAL HOLOGRAMS

Before introducing geospatial holograms into a domain where lives are at high risk, a series of usefulness, acceptance, and usability tests need to be performed. One of the key geospatial hologram design requirements for SWAT incidents was identified as supporting effective route planning and wayfinding. This paper will report about a first pilot study that assessed acceptance and compared wayfinding performance of SWAT team members with a traditional map and a geospatial hologram in a multistory maze.

The study was conducted at a three-story laser tag facility in Austin, Texas. Laser tag is a leisure action game in which participants wear a lightweight vest and carry a futuristic "phaser" to "tag" opponents with a visible laser light beam and score points. At the end of each game, participants receive a score, hit-to-shot ratio, rank, and winning team information. The laser tag facility used in this study was an indoor arena containing a three-dimensional maze consisting of towers, ramps, alleys, and bridges rising up to sixteen feet. Flexible light, sound effects, and fog settings allow for creating custom test environments. For this pilot study we set the lighting level to a low (dim) setting and did not utilize any sound effects, fogging, or tagging equipment.

In collaboration with a commander of the Hays County SWAT team, we designed a 2D tactical map and a geospatial hologram of the laser tag facility. Both geospatial representations were generated at the same scale and media extent. The 2D tactical map (Figure 3) was printed on paper and utilized a five-step grayscale classification and numeric data to indicate height information. Arrowheads indicated ramp slope and direction. The geospatial hologram (Figure 4) showed a three-dimensional representation of the maze. The monochromatic nature of the hologram did not encode color changes or arrowheads to indicate ramp slopes or direction. The walls of the towers and bridges in the hologram were semi-transparent. The paper map and the holographic image of the maze were placed on two different tables in the preparation room and lighted from above. No special user interfaces or additional visual aids were provided to the participants. Participants could freely turn (or walk around) the geospatial hologram and the paper map so that both representations could be studied from any angle.

Eight male SWAT team members from the Austin Police, Hays County, and Travis County SWAT teams participated in this pilot study during their active duty. All participants did not receive previous training in map reading or wayfinding and were novices to geospatial holograms. SWAT commanders gave our initial study a ninety-minute window in which we had access to these domain experts. This narrow time window required us to conduct the study with four observers and one study coordinator to ensure a smooth workflow. Before the arrival of the SWAT team members, we conducted several pilot runs with volunteers from the laser tag facility to filter out any potential on-site problems and to ensure that our observers knew the workflow. Since holograms often astonish first-time viewers, all SWAT team members were introduced to holograms and invited to review a non-study-related hologram to get accustomed to this visualization technology.

"All participants did not receive previous training in map reading or wayfinding and were novices to geospatial holograms."

After being accustomed to the three-dimensional representation potentials of holograms, participants received a numeric ID badge and had to wait in the waiting area without access to holograms or the maze. Two targets, one red and one yellow chair, were placed in separate locations of the maze. The dim lighting of the maze made it possible to conceal the targets in locations not directly visible to the participants. Target one (the red chair) was placed in a location which required a moderate amount of navigation, while target two (the yellow chair) required navigation through several levels of the maze. Each subject participated in a total of four randomly given tasks: 1) a paper map-based search for target one, 2) a hologram-based wayfinding to target one, 3) a paper map-based navigation to target two, and 4) a hologram-based search for target two. The observers working in the preparation room would randomly assign one of these tasks to an incoming participant. The participant would be exposed

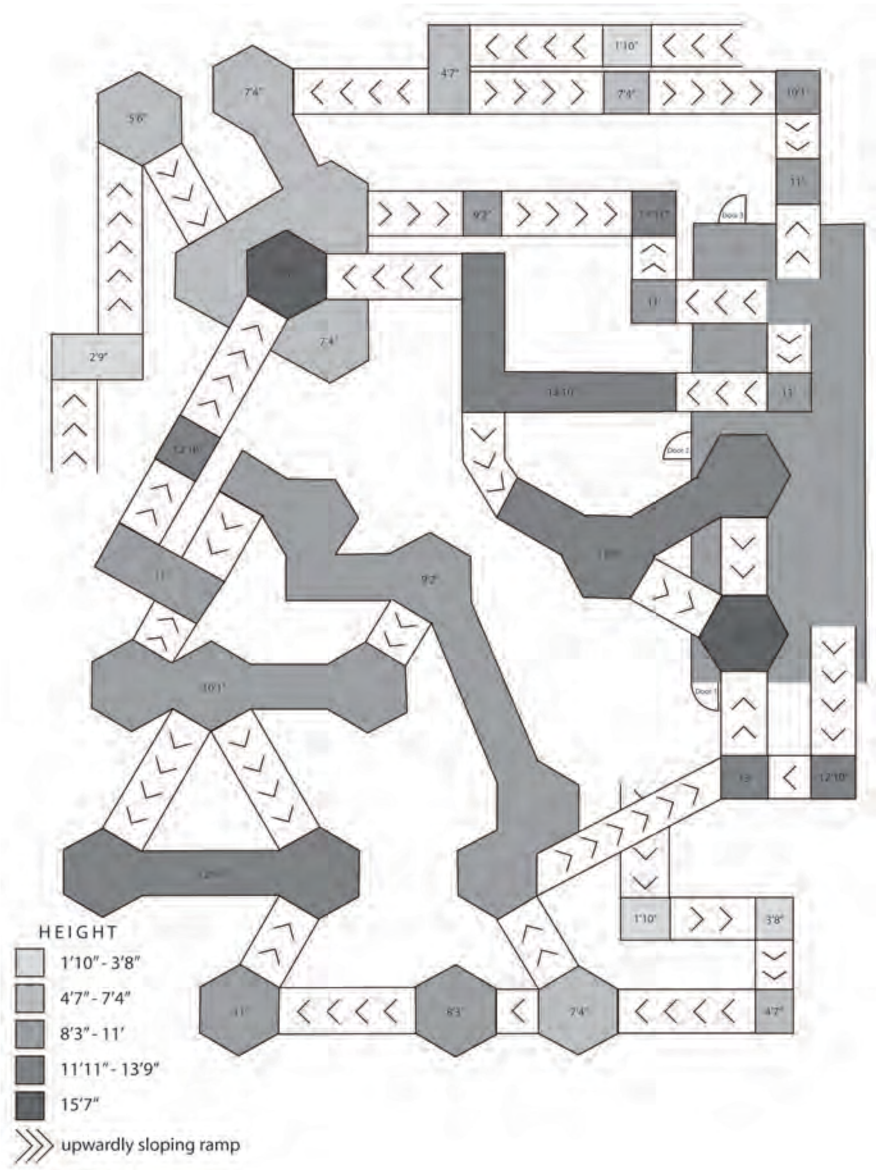

Figure 3. Two-dimensional map of the laser tag facility.

"The participant would be exposed to either the two-dimensional paper map or the geospatial hologram of the laser tag facility, asked to plan a route between the entry point of the maze and target one or two, and would let the observers know when he was finished with route planning."

to either the two-dimensional paper map or the geospatial hologram of the laser tag facility, asked to plan a route between the entry point of the maze and target one or two, and would let the observers know when he was finished with route planning. Participants were not asked to record the planned route, nor were they allowed to carry the spatial representations or any other recordings into the maze. As soon as the subject indicated that he finished route planning, he was guided to the entry point of the maze.

Information about the given wayfinding task was handed to one of the maze-based observers which would follow the participant in the maze and time each participant's wayfinding performance as he attempted to locate the target. Once the wayfinding task was completed, the executed task was marked on the badge and the participant was guided back to the waiting area. Testing was repeated using the different geovisualization media and targets until a participant had taken part in all four tasks. After finishing the wayfinding study, all participants were surveyed about their

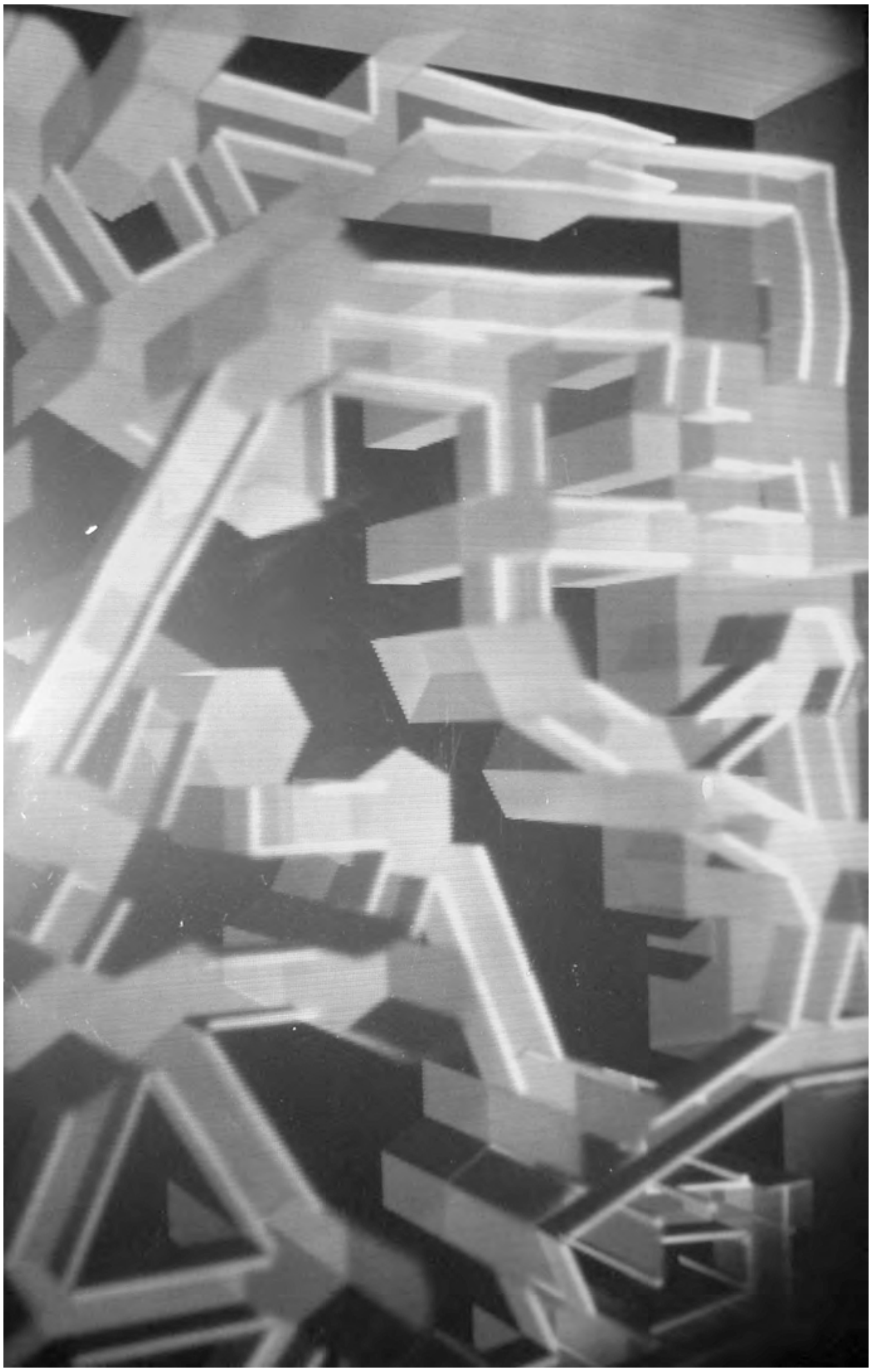

Figure 4. Geospatial hologram of the laser tag facility.

experiences with the hologram-paper map comparison activity and were thanked for their participation.

RESULTS

The search for target one yielded mean values of 38 seconds (SD = 18.4, paper map) and 29 ¼ seconds (SD = 3.8, hologram) while the mean search values for target two resulted in 65 ¾ seconds (SD = 74.6, paper map) and 30¼ seconds (SD = 11.1, hologram). The descriptive statistic results are displayed in Table 1. Overall, the mean times from the search tasks performed by the participants using geospatial holograms were approximately 23 percent faster for target one and 54 percent faster for target two. The relationships of the standard deviations and standard errors also suggest that the times of hologram-based wayfinding are less variable and more evenly distributed than the times of the paper map-based search.

Although the sample size was relatively small for quantitative analysis (it is very difficult to recruit many SWAT domain experts), the paired

	N	Min. (seconds)	Max. (seconds)	Mean (seconds)	Std. Error	Std. Deviation
Hologram, Target 1	8	22	34	29.25	1.34	3.80
Map, Target 1	8	17	72	38	6.53	18.47
Hologram, Target 2	8	16	53	30.25	3.93	11.11
Map, Target 2	8	23	236	65.75	26.39	74.64

Table 1. Descriptive statistics of wayfinding performance.

t-test was conducted for both target searches at a 95 percent confidence interval and used to assess whether the mean time of the tasks completed using the different media were significantly different (Table 2). Overall, the time to complete the first task objective while using the geospatial hologram was not significantly different than when using the paper map ($p = 0.1486$). Subsequently, the time to complete the second task while using the geospatial hologram was also not significantly different than when using the paper map ($p = 0.1739$).

A box plot was created to represent the variability of task completion times for each task objective using the paper maps and geospatial hologram (Figure 5). Especially with smaller sample sizes, box plots are useful in identifying variability and trends when comparing data distributions. The data represented within each box displays the upper and lower quartile in the dataset. The median (black line) in each box indicates the distribution of task completion times relative to the mean. The evaluation of the box plots for both wayfinding tasks suggests that there is a larger amount of variability within the data collected during the paper map tests than the data collected during the geospatial hologram-based wayfinding tasks.

"A second aspect of our pilot study was to assess the general acceptance of geospatial holograms and maps in the SWAT domain."

QUALITATIVE ASSESSMENT

A second aspect of our pilot study was to assess the general acceptance of geospatial holograms and maps in the SWAT domain. Especially in domains where lives are at risk, a new technology is only successfully implemented if it is perceived by the domain experts as helpful and easy to use. After the wayfinding exercise in the maze, the SWAT officers were given a brief questionnaire. The questionnaire consisted of fourteen Likert-scale questions, focusing on spatial representation, remembering height

	Hologram, Task 1	Paper Map, Task 1
Mean	29.25	38
Variance	14.5	341.1428571
Observations	8	8
Pearson Correlation	0.875441414	
Df	7	
t Stat	-1.623086135	
P (T<=t) two-tail	0.148600368	
t Critical two-tail	2.364624251	

	Hologram, Task 2	Paper Map, Task 2
Mean	30.25	65.75
Variance	123.6428571	5572.214286
Observations	8	8
Pearson Correlation	0.780428185	
Df	7	
t Stat	-1.513675942	
P (T<=t) two-tail	0.173875457	
t Critical two-tail	2.364624251	

Table 2. Quantitative analysis of wayfinding performance.

information, recalling route information and general usability aspects, and five open-ended questions eliciting positive and negative aspects, suggestions for improvement, and additional remarks.

When asked if the geospatial hologram or the paper map was an accurate representation of the laser tag facility, seven of the eight participants responded that the geospatial hologram was an accurate representation and six responded that the paper map was an accurate representation. Seven participants stated that the hologram clearly displayed elevations and six participants stated that the paper map did not clearly represent height information. Seven SWAT members found that route planning was easy with the geospatial hologram and four members found that route planning was more difficult with the paper map. Seven participants claimed that they could easily locate the targets in the hologram and recall the route in the maze, and four found it more difficult to find the target and the correct route with the paper map. Height information from the hologram could be remembered by seven participants while six described that it was difficult to remember height information from the paper map. Overall, seven of the total of eight participants stated that holograms might be useful and effective tools in SWAT operations, and five members stated that paper maps are very useful and effective. Figure 6 summarizes the results as mean representation for each question in a radar plot.

When asked about positive and negative aspects of geospatial holograms, the majority of the participants described the holograms as good

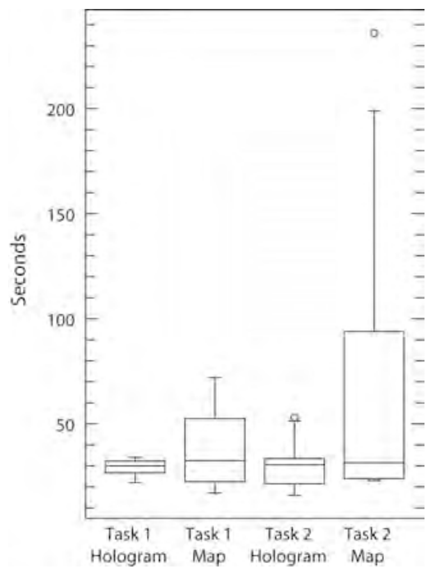

Figure 5. Box-and-Whisker plot of wayfinding performance for both geovisualizations.

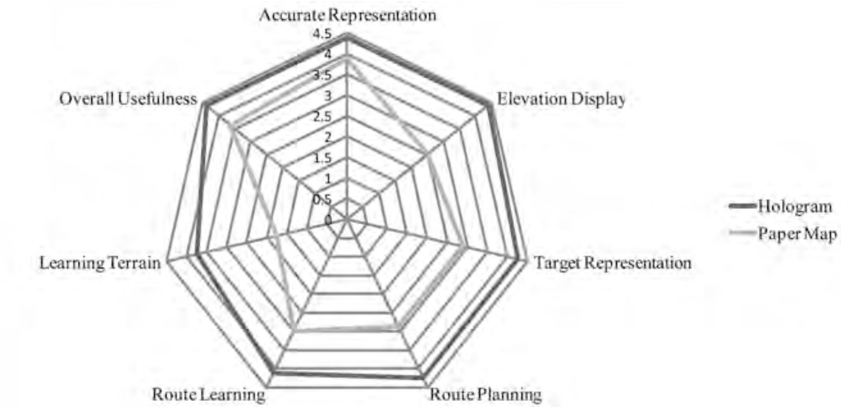

Figure 6. Radar plot of geospatial hologram and paper map assessment.

reference to plan routes, with obvious structure representation, three-dimensional object and elevation display, and an element of realism. Some participants worried about the cost of the technology, light settings, and the timeframe to produce a geospatial hologram for a specific incident. The paper map provided many participants with a sense of familiarity and was favorably viewed for being comparatively more portable and foldable. Participants described the longer time required to depict elevation and height information as a negative aspect of the paper map. Overall the geospatial hologram was described by the majority of participants as easy to read, because "it was like looking down at the maze" (participant 5) and it provided a realistic image of the environment showing "all sides of the location and routes" (participant 4). Most of the participants saw an immediate need and an intrinsic value in geospatial holograms, specifically with respect to its ease of use, and practical applications towards tactical planning, training, executing search warrants, rescue, and tactical response in hostage situations and other life-threatening incidents.

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CONCLUSION

Geospatial holograms hold the potential for more widespread research and application in cartography. Norman (1998) argues that in any domain each of five possible user categories–innovators, early adopters, pragmatists, conservatives, and skeptics–have specific preferences and goals that need to be considered when designing technology. Currently, geospatial holograms are evolving from the tools of innovators and early adopters to the broader audience of pragmatists and conservatives. This process brings up many open research and development questions that need to be addressed in cartographic research before introducing the technology into real-world situations. Besides the SWAT application domain, we can envision many holographic applications in cartography ranging from reference maps, urban landscape visualizations, and geomorphologic representations to special thematic maps.

Holographic technology has resisted incorporation with mainstream visualization technology for multiple reasons, including the high degree of difficulty and long length of time for production, high cost, and inconvenient restrictions on features such as size, color representation, and viewing angles. These limitations are now starting to vanish with the development of more advanced and effective holographic software and hardware. However, current holographic technology does not allow instant hologram generation or real time data processing, a major shortcoming compared to standard Web-mapping services. On the opposite side, geospatial holograms support three-dimensional object visualizations that cannot be provided through standard Web-mapping services or paper maps. This “true” three-dimensional representation ability could have a major impact on building a common operational picture by supporting geospatial intelligence gathering, tactical planning, operation, collaboration, and response.

Our initial research and collaboration in the SWAT domain indicates that geospatial holograms could hold great potential to support many aspects in high-stress law enforcement situations. The goal of our pilot study was to investigate if geospatial holograms might support effective route planning and wayfinding in SWAT situations and if this geovisualization technology might be seen by these domain experts as useful and effective technology. Although our quantitative analysis did not reveal significant differences between the use of holograms and paper maps for wayfinding tasks, our qualitative data analysis indicates positive responses towards the use of geospatial holograms during SWAT incidents.

“Our initial research and collaboration in the SWAT domain indicates that geospatial holograms could hold great potential to support many aspects in high-stress law enforcement situations.”

Obviously, the paper map and Web mapping technologies will not vanish from the SWAT domain, or as one participant puts it: “a paper map is better than nothing” (participant 6). Thus, it is our goal to investigate how to design and implement complementary geovisualization technologies for better and safer law enforcement. Snow (1996) notes that in SWAT operations the difference between success and failure is a matter of timing, often separated by seconds. If we can advance geovisualization, especially geospatial holographic technology, to provide our law enforcement personnel with extra time to operate effectively, efficiently, and successfully in crisis situations, this technology will quickly move from the early innovation stage to the hands of pragmatic and conservative users. Future user testing in a human-centered design approach will provide us with important indicators about the design and redesign of geospatial holograms for SWAT operations.

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REFERENCES

Bailey, Steven. 2006. Pierce County, Washington, Pierce County Responder System. *URISA Journal* 18 (1): 7-13.

Benton, Stephen A., and V. Michael Bove, Jr. 2008. *Holographic imaging*. New York: Wiley-Interscience.

Bevan, Nigel, and Ian Curson. 1999. Planning and implementing user-centered design. Paper read at CHI 1999, Adjunct Proceedings, at Pittsburgh.

Bolz, Frank, Jr., Kenneth J. Dudonis, and David P. Schulz. 2001. *The counterterrorism handbook: tactics, procedures, and techniques*. 2nd ed. Boca Raton: CRC Press.

Cappel, Robert P. 1979. *S.W.A.T. team manual*. Boulder: Paladin Press.

Greene, R. W. 2002. *Confronting catastrophe: A GIS handbook*. Redlands, CA: ESRI Press.

Grindle, Charles, Michael Lewis, Robin Glinton, Joseph Giampapa, Sean Owens, and Katia Sycara. 2004. Automating terrain analysis: Algorithms for intelligence preparation of the battlefield. Paper read at Proceedings of the Human Factors and Ergonomics Society, 48th annual meeting, at New Orleans.

Hariharan, P. 2002. *Basics of holography*. Cambridge: Cambridge University Press.

Heal, Sid. 2005. *An illustrated guide to tactical diagramming*. New York: Lantern Books.

Heckman, Philip. 1986. *The magic of holography*. New York: Atheneum.

Jones, Tony L. 1996. *SWAT leadership and tactical planning: The SWAT operator's guide to combat law enforcement*. Boulder: Paladin Press.---. 2001. *Effective response to school violence: A guide for educators and law enforcement personnel*. Springfield, Il: Charles C. Thomas.

Kasper, Joseph E., and Steven A. Feller. 2001. *The complete book of holograms: How they work and how to make them*. Mineola, NY: Dover Publications.

Kolman, John A. 1982. *A guide to the development of special weapons and tactics teams*. Springfield, IL: Charles C. Thomas.

Leipnik, Mark R., and Donald P. Albert, eds. 2002. *GIS in law enforcement: implementation issues and case studies*. Boca Raton: CRC Press.

Mijares, Tomas C., Ronald M. McCarthy, and David B. Perkins. 2000. *The management of police specialized tactical units*. Springfield, IL: Charles C. Thomas.

National Geospatial-Intelligence Agency. 2008. NGA today. http://www.nga.mil/NGASiteContent/StaticFiles/OCR/ngatoday.pdf.

Norman, Donald A. 1999. *The invisible computer: Why good products can fail, the personal computer is so complex, and information appliances are the solution*. Cambridge, MA: MIT Press.

O'Sullivan, Patrick. 1991. *Terrain and tactics*. New York: Greenwood Press.

Snow, Robert L. 1996. *SWAT teams: Explosive face-offs with America's deadliest criminals*. New York: Plenum Press.

Sorensen, Severin L. 1998. Smart mapping for law enforcement settings: Integrating GIS and GPS for dynamic, near real time application and analyses. In David Weisburd and Tom McEwan, eds. *Crime Prevention Studies.* Monsey, NY: Criminal Justice Press.

U.S. Department of Justice. Office of the Inspector General. 2006. A review of the September 2005 shooting incident involving the Federal Bureau of Investigation and Filiberto Ojeda Ríos. Washington, DC.

Wang, Fahui, ed. 2005. *Geographic Information Systems and Crime Analysis*. Hershey: Idea Group Publishing.

Asymmetrical Learning of Locations on Maps: Implicit Learning, Prior Knowledge and Sex Differences

David K. Patton
Central Michigan University

Robert Earl Lloyd
Univ. of North Carolina - Greensboro

Women have been reported to have an advantage for the memory of unique objects in space while men have been reported to have an advantage on tests of knowledge of geographic information. The current research considers how prior knowledge and asymmetrical learning processes might be related to this apparent contradiction in the literature concerning spatial cognition. Asymmetrical brains allow us to encode map locations as both categorical and coordinate information. Categorical information is expressed verbally, for instance, "City A is located in the northwest quadrant of the map," and is easier to learn but not very precise. Coordinate information is more precise but takes longer to learn. Prior knowledge of locations may result in subjects relying more on coordinate information.

Human subject testing was used to examine differences in performance when women and men learned and recalled city locations on maps. Learning was achieved through the use of a repeated search task. Results indicated that subjects implicitly learned the locations of cities during the search task. The distribution of the cities on the maps and whether the cities were known or novel affected performance. The evidence supports the assertion that men may have a greater interest in geographic information, and the additional attention they devote to such information allows them to utilize prior knowledge and gives them an advantage when processing well-known places. The evidence also supports the assertion that women may generally have an advantage learning novel maps because they tend to encode more categorical information, and this information is useful for remembering general locations and can be learned faster.

Key Words: maps, prior knowledge, sex, gender, asymmetrical learning, categorical information, coordinate information.

The universe is asymmetric (Pasteur 1874, 76).

INTRODUCTION

Consider how someone might encode the spatial locations of a set of cities on a cartographic map into memory. One strategy might be to encode a whole image of the map. Once acquired, this image could provide coordinate information. One could recall that image if information on the map, for instance, a location, distance, or direction, were needed for a subsequent task. A map reader could also use a verbal strategy to encode spatial information, such as, "City A is in the center of the map" or "City B is in the upper-right quadrant of the map." This information would also be useful for tasks that did not require precise information. The current

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research considers asymmetrical learning processes as an explanation for a puzzling inconsistency in the spatial cognition literature. Men have been reported to have an advantage on tests of knowledge of geographic information while women have been reported to have an advantage for the memory of unique objects in space. For an excellent and thorough review of the advantages and disadvantages of having an asymmetrical brain, see Vallortigara and Rogers (2005). For a discussion of brain lateralization related to spatial abilities, see Lloyd 2003. For examples of brain lateralization issues related to cartography, see Lloyd and Bunch (2005, 2008).

This research is based on three primary postulates. Postulate One: *Spatial information can be learned and stored in different ways* Asymmetrical brains are an advantage in spatial cognition in that they provide cognitive processing abilities that are adapted to a variety of situations that might require the learning and use of spatial knowledge. This asymmetry allows relationships among objects in space to be represented as both category information and coordinate information. The category information is abstract, verbal, and associated with the left hemisphere of the brain. The coordinate information is metric and associated with right hemisphere activity (Jager and Postma 2003). If coordinate information has been encoded, one can recall spatial knowledge that is more precise. In a very familiar environment, a person you might know there are fifty steps between the front door and the mailbox. Less precise spatial knowledge can be recalled if one has encoded categorical information. In a novel environment, people might know that they parked their cars on the top of a parking garage (Kemmerer 2006). In the context of acquiring a cognitive map by learning information directly from the environment, an individual might use alternate cognitive processes based on a need for a type of processing or a strategy for producing the best performance (Lawton and Kallai 2002; Choi et al. 2006). The selection of a given cognitive process might be made consciously or unconsciously. It is also possible that the use of learning styles might become habitual behaviors that are neither consciously preferred nor strategic (Danner, Aarts, and de Vries 2007). Nori and Giusberti (2006) suggested different cognitive styles were correlated with performance. Their results indicated relative success on nine different spatial tasks was related to three cognitive styles.

"Asymmetrical brains are an advantage in spatial cognition in that they provide cognitive processing abilities that are adapted to a variety of situations that might require the learning and use of spatial knowledge."

Postulate Two: *The most efficient learning strategy for individuals ca change with experience.* Individuals who are very familiar with a map (or an environment) are more likely to have encoded prior knowledge that can provide flexible, top-down guidance to maximize the efficiency of visual processes such as searching for a particular place (Wolfe et al. 2004). The most efficient learning process for a novice, however, is not always the most efficient learning process for an expert (Kalyunga et al. 2003). The accuracy of one's cognitive map and the ability to use it efficiently (as in a visual search process) is dependent on both categorical and coordinate information (Huttenlocher, Hedges, and Duncan 1991). Categorical spatial information should be easier to encode than coordinate information and should be more useful for individuals who are less interested, less motivated, or have had less time to encode coordinate information into their cognitive maps. Although coordinate information takes longer and is more difficult to encode, it ultimately will produce the most accurate cognitive maps that can be used most efficiently.

"The most efficient learning strategy for individuals can change with experience."

Postulate 3: *Sex differences related to cognitive mapping are related to asy - metrical learning strategies.* It has been suggested that females and males may prefer different strategies for processing spatial information (Dabbs et al. 1998). When levels of experience are low, an individual relying more on categorical learning strategies should perform better than individuals relying more on coordinate learning strategies. As the time and effort devoted to learning increases, the effect should reverse, with individuals relying more on coordinate strategies performing better than individuals relying more on categorical strategies.

BACKGROUND LITERATURE

Spatial Information: Categorical and Coordinate Strategies

Evidence that spatial locations are encoded as categorical and coordinate information by separate coding processes in the left and right hemispheres of the brain was first presented by Kosslyn (1987), followed by Kosslyn, Gitelman, and Alpert (1989)[1]. For a review of the topic, see Jager and Postma (2003) and Postma and Laeng (2006). Other researchers have recently supported this hypothesis with evidence from brain scanning studies (Slotnick and Moo 2006; Trojano et al. 2006; van der Lubbe et al. 2006). Research that has supported this notion has connected it to divergent strategies for processing spatial information that are thought to be preferred by females and males (Rybash and Hoyer 1992; Saucier et al. 2002; Coluccia, Iosue, and Brandimonte 2007). Categorical or verbal strategies, processed in the left hemisphere, are hypothesized as more preferred by females; and coordinate strategies, processed in the right hemisphere, are hypothesized as more preferred by males. Sex differences in cognitive processing have been connected to evolutionary theories of brain asymmetry that have genetic explanations (Casey 1996; Annett 2002; Lloyd 2003). Evidence for preferred strategies have been shown for mental rotation tasks (Butler et al. 2006; Hugdahl, Thomsen, and Ersland 2006), navigation (Choi et al. 2006; Barkley and Gabriel 2007), map drawing (Lee and Bednarz 2005; Coluccia, Iosue, and Brandimonte 2007), and spatial memory tasks (Frings et al. 2006; Voyer et al. 2007).

"Sex differences in cognitive processing have been connected to evolutionary theories of brain asymmetry that have genetic explanations."

Geographers have considered how sex is related to a variety of basic spatial tasks (Montello et al. 1999). They reported that male subjects located world cities more accurately than females, and female subjects were superior on an object-location memory task. Performance differences between male and female subjects also have been reported for rotated and animated maps (Lloyd and Bunch 2005; Griffin et al. 2006). Lloyd and Bunch (2008) argued that gender could be a more informative explanatory variable than sex for explaining map-reading performance. Their results supported other studies suggesting non-linear relationships relating sex, brain lateralization, and accuracy.

"Lloyd and Bunch argued that gender could be a more informative explanatory variable than sex for explaining map-reading performance."

An individual may not consciously decide to encode either categorical or coordinate information but could spontaneously encode both types. It has been argued that coarse-grained categorical and fine-grained coordinate information are both encoded in memory and combined to make estimations of learned spatial information. Huttenlocher, Hedges, and Duncan (1991) introduced the idea that some location errors are due to what they called *prototype effect* and suggested, "These processes introduce bias in reporting even when memory is unbiased, but nevertheless may improve overall accuracy (by decreasing the variability of reports)" (352). They reported on a simple experiment where subjects reported the location of a dot in a circle. If the circle were to become a more complex map outline and the dot were to represent a city, the basic idea could easily be transformed into a cognitive mapping investigation.

The Huttenlocher, Hedges, and Duncan (1991) study suggested that subjects apparently partitioned the circle into left-right and upper-lower regions, and dots were encoded as being in one of the four quadrants, for example, in the upper-right quadrant. The center of a quadrant represented the most probable coordinate location to estimate if only the dot's quadrant category were remembered. Someone who ignored categorical information and only encoded coordinate information might estimate locations with relatively lower accuracy because coordinate information is more difficult to encode. Someone who ignores coordinate information and encodes only categorical information could never be extremely accurate over a set of locations in an extended space because only coarse-grained prototype information could be used to make estimates. Since people are capable of encoding both categorical and coordinate information, how they combine the two information sources determines overall performance. This becomes even more complicated when multiple visual fields must be considered.

"Since people are capable of encoding both categorical and coordinate information, how they combine the two information sources determines overall performance."

When a cartographic map is larger than a viewer's visual field, the viewer has to focus on part of the map and refocus attention to move the visual field. The sequence of such moves can potentially cause response times that are spatially biased. Performances on spatial tasks involving visual search and learning locations on maps should vary with the size of the map and the number of potential target locations. The size of the viewer's visual field relative to the size of the map being searched determines how frequently attention must be refocused to reposition the visual field. Eye-movement and experimental studies on optimal visual field size have indicated a window with a visual angle of approximately 9 degrees produced optimal performances (Enoch 1959; Wood 1993; Hodgson 1998; Lloyd, Hodgson, and Stokes 2002).

Theories of visual search are related to how attention is allocated during the search for a target (Proulx and Egeth 2008). Evidence from studies on how cartographic maps are searched suggests map readers may make categorical distinctions between central locations and locations near peripheral boundaries. Spatial search studies involving searching for color boundaries on choropleth maps have reported asymmetrical response times for targets in central versus peripheral locations (Brennan and Lloyd 1993; Bunch and Lloyd 2000). It has yet to be determined if asymmetrical performances should be expected with other map reading tasks and types of maps, or if the same asymmetries should be expected for the accuracy of recalled locations.

"Evidence from studies on how cartographic maps are searched suggests map readers may make categorical distinctions between central locations and locations near peripheral boundaries."

Prior Knowledge

Early studies that used real-world maps have suggested that categorical information affected location accuracy. Stevens and Coupe (1978) first reported results that suggested a hierarchical organization in cognitive maps with super-ordinate categories, such as states, affecting the accuracy of subordinate locations, such as cities, in cognitive maps. Tversky (1981) first reported that people tend to align continents, and, therefore, inaccurately recall the locations of cities on the continents. More recently, experiments requiring subjects to recall the latitude and longitude of cities indicated cognitive mappers tended to group cities into categories, such as regions, and align the regions, thus affecting the accuracy of city locations (Friedman and Brown 2000a, 2000b).

A recent study considered if recalling location information from a newly learned hypothetical map was similar to recalling location information from a well-learned real-world map. The authors concluded, "Overall these experiments suggest that 'book learning' of geography is likely to be much more figurative and much less categorical than knowledge of real geography, which is gained partly from text read and thought about over many years, as well as from film, TV shows, conversations and actual travel" (Newcombe and Chiang 2007, 908). Although there are many potential sources for information that might provide spatial knowledge in a cognitive map, it is possible under controlled learning conditions to assume information about the spatial locations of cities is new and only learned from map-reading experiences.

The notion that reference points and linear or aerial features in the environment have an important influence on environmental learning is not a new idea. Examples related to urban environments are the anchor point theory (Couclelis et al. 1987) and the elements of the environment (paths, edges, districts, nodes, and landmarks) that provide the image of a city (Lynch 1960). More recently, a parallel map theory has been discussed in the literature (Jacobs 2003; Jacobs and Schenk 2003; Jacobs 2006). This theory argues the hippocampus encodes spaces with two mapping systems that can be integrated into cognitive maps. One system encodes frames of reference that can provide context and structure, and the other system encodes positional cues for landmarks. The theory argues the two spaces are integrated to provide a third space that is a usable cognitive map.

"Even if cognitive mappers are not using information that is extremely precise, they may still be able to encode useful spatial information."

Adam, Hommel, and Umilta (2003, 308) argue, "There is strong behavioral and neurophysiological evidence that the brain codes visual information in multiple frames of reference, with the frame of reference dominating performance being dependent on the task demands." If this notion is generally true for encoding visual information, aggregate cognitive maps encoded from cartographic maps should be the product of individual encoding processes based on multiple frames of reference. The question then becomes, at any given time, what frames of reference dominate performance with the task demands associated with map learning?

Even if cognitive mappers are not using information that is extremely precise, they may still be able to encode useful spatial information. It is possible with precise information to encode either a polar or Euclidean coordinate for an object in space. A point as a reference object would allow the assessment of the proximity to other objects and their direction from the reference object. In the Figure 1a example, Cities 3 and 1 are east and west of the home reference city, and City 1 is twice as far from home than City 3. A line as a reference object would allow one to encode other objects' locations on either side of the line and their proximity to the line. In the Figure 1b example, Cities 3 and 4 are each the same distance from the river on the river's left and right banks as it flows toward the top of the figure. The boundary of an area could serve as a container. One could encode objects as being inside or outside the container and their proximity to the center or edge of the container. In the Figure 1c example, Cities 1 and 4 are inside and Cities 2 and 3 are outside the bounded region. City 4 is closer to the center of the region, and City 1 is closer to the boundary.

"An exception to any general spatial advantage for males is a consistent female advantage for object location memory."

Sex Differences and Cognitive Maps

Although the evidence is not completely consistent, the general notion that females will perform better than males on many tasks that require the processing of verbal information appears to be accepted (Maccoby and Jacklin 1974; Voyer, Voyer, and Bryden 1995; Halpern 2000; Kimura 2000). Males appear to have a similar advantage on many tasks that require the processing of spatial information. An exception to any general spatial advantage for males is a consistent female advantage for object location memory (Voyer et al. 2007). Silverman and Eals (1992) proposed the hunter-gatherer theory to explain the sex differences in spatial abilities.

The evolutionary argument for a male advantage is that pre-agricultural males had a greater home range than females, resulting in experiences with larger geographic environments (Jones, Braithwaite, and Healy 2003; Ecuyer-Dab and Robert 2004a). Successful hunters were frequently in unfamiliar environments where they needed to navigate, track game, and throw objects at prey (Watson and Kimura 1991; Silverman and Eals 1992; Silverman et al. 2000). Natural selection allowed successful hunters to survive and pass on their traits (Choi and Silverman 2003). Sexual selection of these traits also provided an evolutionary advantage for good hunters (Hawkes 1991; Miller 2001; Ecuyer-Dab and Robert 2004b).

Pre-agricultural females evolved an advantage in memory for object locations (Eals and Silverman 1994; Tottenham et al. 2003; Neave et al. 2005). Women had child-care responsibilities and a more limited spatial range (McBurney et al. 1997). They increased their chance of survival if incidental learning allowed them to recall food sources in relatively small and familiar local environments (McGivern et al., 1997; 1998).

It is not clear what one should expect about the relative success of males and females on spatial tasks that required learning and recalling information on maps. The hunter-gatherer theory predicts advantages for males and females that were evolved through environmental experiences that may or may not translate into map-reading abilities.

Considerable evidence suggests that men tend to do better on general tests of geographic knowledge (Cross 1987; Bein 1990; Eve, Price, and Counts 1994; Henrie et al. 1997; Dabbs et al. 1998; Nelson, Aron, and Poole 1999). Zinser, Palmer, and Miller (2004) had subjects match city names with map locations using cartographic maps to support the task. No significant sex difference was found when females and males matched names with campus buildings or blank U.S. states. In other experiments, they allowed cities to vary in distance by using sets of local (within 100 miles), national, and international cities. Their results indicated a significant advantage for men at all three scales. They concluded that this advantage was "a joint product of nature and nurture" (Zinser, Palmer, and Miller 2004, 661). The authors used a preparedness theory to come to this conclusion (Seligman 1970). It was suggested that "Women and men have an opportunity to overcome any lack of preparedness (unpreparedness) with additional effort" (Zinser, Palmer, and Miller 2004, 681). They argued men had enough experience with the campus buildings to overcome a natural verbal advantage of women in this local environment, and women had enough educational experience with U.S. state maps to overcome a natural advantage men have with this larger environment. It was argued, "that men displayed

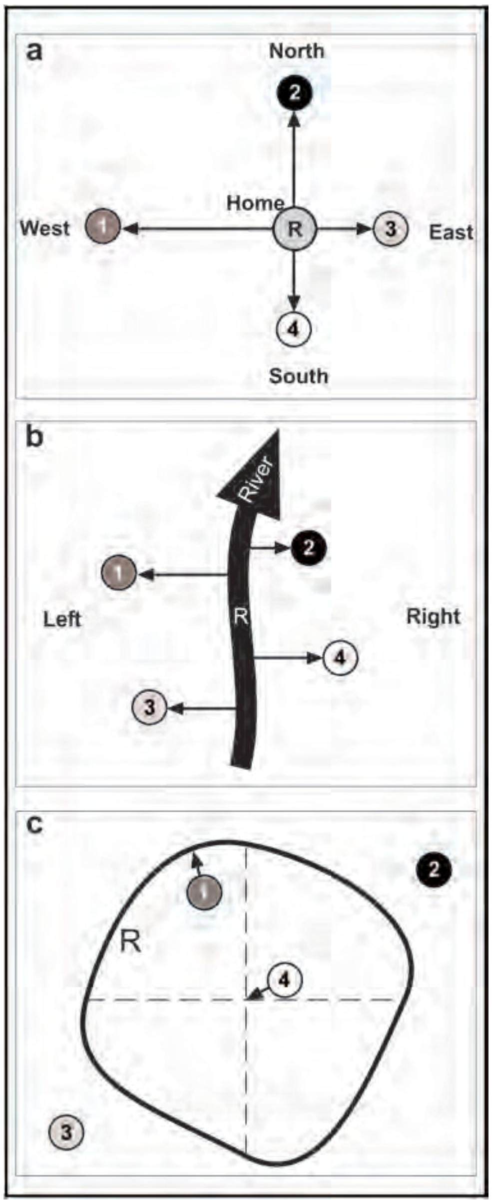

Figure 1. A point, line (b), or area (c) could be used as a reference frame.
Cities could be remembered by coding their relative location to a home city (a), their relative location with respect to a river (b), and relative location inside or outside a region or near a central or boundary location (c).

greater knowledge of cities and international sites suggests that they have a greater interest in geography than do women" (Zinser, Palmer, and Miller 2004, 661). This notion is supported by other studies that compared geographic knowledge for females and males (Beatty and Bruellman 1987; Beatty and Tröster 1987; Liben 1995).

RESEARCH DESIGN

There were two main tasks for this experiment, a learning task and a recall task. All subjects were presented with an outline map with thirty cities labeled as point features on a color computer monitor. Using the computer mouse to interact with the map, subjects searched for and located each of the thirty cities as quickly and accurately as possible. Cities' names were presented to the subjects randomly one at a time on the screen above the map. This task was repeated seven times to ensure that the subjects had an opportunity to learn the locations of the cities on the map. For the final task of the experiment, subjects were presented the same outline map with no cities. City names, with points, were then presented to the subjects randomly, one at a time, and their task was to drag the city to its correct position on the map. Three different outlines and city combinations were used in the experiment. Details of each map condition are described below.

"Using the computer mouse to interact with the map, subjects searched for and located each of the thirty cities as quickly and accurately as possible."

Subjects

Ninety subjects, enlisted from undergraduate students enrolled in geography courses at Central Michigan University, participated in the experiment. Thirty subjects, balanced for sex, viewed each of the three test maps described below. A brief statement was read to the student describing the nature of the experiment. The potential subjects were told that the experiment would involve working with a map presented on a computer monitor to find a series of cities on the map. They were also informed that the experiment would take approximately twenty minutes to complete, that there would be no compensation for participation, and that they could quit at any time. While all of the subjects came from introductory geographic information science (GISci) courses, most were not GISci majors. It was assumed the subjects represented a population of young adults that had more than a typical interest in maps and geographic information since they selected a geography course as part of their curriculum. Most of the subjects were from Michigan, and all currently reside in Michigan. Other than a general knowledge of cities in the United States that could be expected from someone living in Michigan and some interest in geography, no specific expertise or skills were required for this experiment.

"This task was repeated seven times to ensure that the subjects had an opportunity to learn the locations of the cities on the map."

Experimental Maps

Three maps were presented to subjects in this experiment (Figure 2). Each map consisted of a background base map showing land area with a coastline and a set of thirty labeled points. No additional reference features, such as state or provincial boundaries, roads, rivers, or inland lakes, were provided, and no graticule was presented with the map.

For Map 1 the base map was a simplified version of the eastern two-thirds of North America centered within the view window approximately on Indianapolis, Indiana. The points labeled for Map 1 were thirty well-known cities in the U.S. and Canada. The only city that might not be considered "well known" was Sault St. Marie, Michigan. All of the subjects for

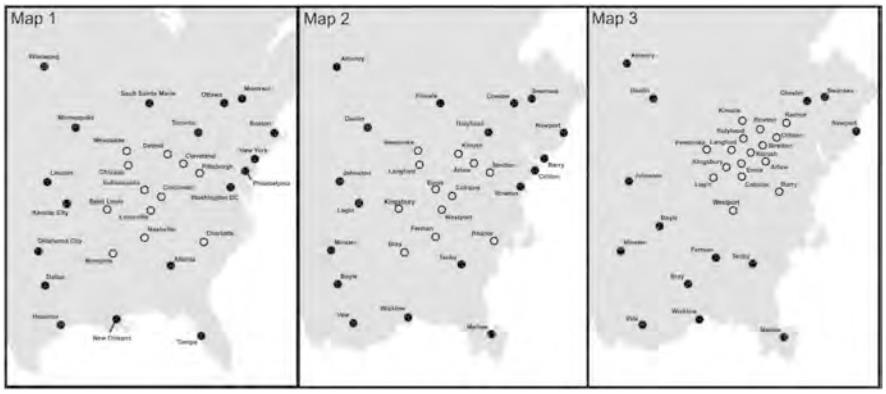

Figure 2. Map 1 represented a true background and true city locations and names. Map 2 represented a false background with true city locations and false names. Map 3 represented a false background with clustered city locations and false names. (see page 89 for color version)

this experiment, however, were currently living in the State of Michigan, and Sault St. Marie is well known to Michigan residents.

Map 2 was presented with a fictional base map that covered approximately the same area of the view window as Map 1 but would not be recognizable to the subjects as a known place. While the map was not recognizable as a real place, it shared many of the general characteristics of the North American map, such as an eastern coastline, bays, and peninsulas. The labeled points for Map 2 were located in exactly the same position as the thirty cities from Map 1, but the names were all changed. The names selected for Map 2 were all Anglo-Saxon in origin, but were not well-known U.S. city names. The subjects who viewed Map 2 viewed cities with the same spatial pattern as the subjects who viewed Map 1, but the Map 2 subjects had no prior knowledge of the places they were viewing.

"The inner focus region represented a single central visual field, while the other focus regions represented multiple visual fields around the outer edge of the maps."

Map 3 was presented with the same base map and the same city names as Map 2. For Map 3, however, the location pattern for the cities was altered to create an obvious central cluster.

Visual Fields on the Map

City locations were represented on the maps as small black dots and labeled with only their appropriate names (Figure 2). Although not represented on the map viewed by the subjects, each city was assigned for the purpose of analysis as an inner focus city or an outer focus city (the inner focus cities are grey on the maps shown in Figure 2). This was done to represent in a binary way where one would have to focus attention to find that city. Following Wood (1993), the inner focus region was defined as a square area centered on the center of the map and defined by a 9-degree visual angle. An outer focus city was defined as any city nearer the boundary of the map that was outside the central region. The inner focus region represented a single central visual field, while the outer focus regions represented multiple visual fields around the outer edge of the maps. All cities in the cluster of cities on Map 3 were inside the central visual field.

"Each subject determined independently how the explicit learning could be achieved."

Experimental Procedures

There were four parts to the experiment, which all subjects completed. During part one, subjects were shown one of the maps discussed above. They were told to study the names and locations of the cities on the map and that, later, they would be asked to locate the cities from memory. All test groups were given two minutes to study the map to obtain a general knowledge of the map that they would be learning. For this explicit learning stage, subjects were not instructed on how they were to encode the city locations into memory. Each subject determined independently how the explicit learning could be achieved.

After viewing the map for two minutes, the subjects were prompted to click a "next" button and move on to part two. For part two, the subjects practiced a search task to become familiar with the experimental search task. The base map was presented with a set of five cities that were not on the experimental map. (Names used during this phase were "alpha," "beta," "delta," etc.) They were told that once they clicked the "next city" button, the name of one of the cities would appear at the top of the display and their task was to search the map for that city and identify it by using the computer mouse and clicking on the city's point. A millisecond clock was started when the "next button" was clicked and stopped when the selected city name was clicked. *Reaction time* was defined as the number of milliseconds that elapsed between the first and second mouse click. Subjects were informed that the goal was to find each city as quickly and accurately as possible. After locating the five practice cities, the average time needed to locate the cities and overall accuracy were presented in a window to the right of the map. It was expected that accuracy would be close to 100 percent for the practice search task and the experimental search task. This was found to be true.

The subjects were told that they would complete the same task for part three but would be searching for the thirty cities they had studied in part one. They were then given the opportunity to either repeat the practice search task or to continue on to do the experimental search task with the thirty cities. They were also told at this time that they would repeat the search task for all thirty cities seven times and their goal was to be as fast and accurate as possible for each round.

The goals for the third stage were to ensure that learning was actually occurring while the subjects searched the cities on the experimental map and to determine if there were any significant patterns to their learning. A pilot study had established that times might be expected to decrease significantly for approximately seven rounds of learning and then remain at a threshold level. To eliminate any order bias, the cities were presented to the subjects in random order for each round. Subjects were able to dictate the pace of the experiment by their selection of the "next city" button. A new city name would not appear at the top of the screen and the clock would not start measuring reaction time until the subjects clicked the "next city" button.

For the fourth part of the experiment, subjects completed a memory task. After completing the experimental task (part three), the complete map appeared on the screen, and subjects were given a second opportunity to study the complete map. It was explained that, when they were ready, they would be shown a blank map (with no cities), and that a point with a city name would appear on the right side of the display. Their task was to grab the city using the mouse and drag it to the position on the map where they recalled that city's dot being located. They continued this for all thirty cities. Once a city was added to the map, it remained. Subjects were able to make adjustments to locations as they went along. Once they had placed the final city and then clicked for a new city, the program controlling the experiment wrote the final coordinates to a file. Reaction time was not recorded for the memory task.

"The goals for the third stage were to ensure that learning was actually occurring while the subjects searched the cities on the experimental map and to determine if there were any significant patterns to their learning."

"Their task was to grab the city using the mouse and drag it to the position on the map where they recalled that city's dot being located."

Variables and Hypotheses

For the learning stage of the experiment, the dependent variable was always reaction time measured in milliseconds for the following Repeated Measure Analyses of Variance. Reaction time was measured for the trials of the search task for seven separate repeated learning epochs**.** An epoch was the repeated measure in the analyses. The tested null hypothesis related to epoch was that mean reaction times would be constant over the epochs. Implicit learning would be confirmed if the null hypothesis for epoch was rejected.

"Implicit learning would be confirmed if the null hypothesis for epoch was rejected."

One main effect in the models was the map viewed by the subjects. The map main effect represented a difference in prior knowledge when comparing the performance of Map 1 and Map 2 subjects. It represented a difference in the spatial distribution of the cities when comparing the performance of Map 2 and Map 3 subjects. The tested null hypothesis related to map was that mean reaction times would be equal for the maps being compared. Rejecting the null hypothesis for map would indicate a significant processing time advantage for the subjects using one of the maps.

Another main effect in the models was sex. The tested null hypothesis related to sex was that the mean performance of female and male subjects would be equal. Rejecting the null hypothesis would indicate either female or male subjects had a significant performance advantage on the experimental task.

The final main effect in the models was focus. The tested null hypothesis related to focus was that subjects performed the experimental task equally well when searching for central and peripheral city locations. Rejecting the null hypothesis would indicate the regional location of cities significantly influenced task performance and could add support for the prototype effects posited by Huttenlocher, Hedges, and Duncan. (1991). This is based on the notion that subjects would code prototype locations for multiple visual fields.

For the recall portion of the experiment, the dependent variable was the cognitive, or recalled, locations from the subjects. The recalled locations were compared to the actual locations. Several types of positional errors were possible; therefore, indices were calculated to establish if differences in the cognitive and actual locations were related to horizontal or vertical shifts, rotations, or scale changes. The ideal expectation was that subject's recall of the city locations would match the actual locations of the cities based on the maps they studied.

"Female subjects were expected to learn the locations of novel cities more easily and, therefore, were expected to have faster mean reaction times for Map 2."

Results: Map 1 versus Map 2

The primary reason subjects were required to do seven replications of the search task was to provide them a controlled structure that allowed them to easily learn the city locations. Subjects searching Map 1 were expected to have a faster and relatively flat learning curve because of the advantages provided by prior knowledge of the city names and locations. Subjects searching Map 2 were expected to have a slower and relatively steep learning curve because they started the first search with relatively little prior knowledge but could acquire useful information during each epoch that could be used in later epochs.

Male subject were expected to have more prior knowledge related to known cities and, therefore, were expected to have faster mean reaction times for Map 1. Female subjects were expected to learn the locations of novel cities more easily and, therefore, were expected to have faster mean reaction times for Map 2.

Following the claim of Huttenlocher, Hedges, and Duncan (1991) that viewers encode both categorical and coordinate spatial information, the focus main effect also was expected to be significant with peripheral cities having a mean reaction time advantage, particularly when learning novel city locations.

Repeated Measure Analysis

The reaction times for the seven search tasks performed by each subject were aggregated over the subjects and used as the dependent variables in a repeated measure analysis of variance (Table 1). In this model, learning epoch (Epoch 1 through Epoch 7) was the repeated measure. Within-subject effects considered the significance of the repeated measure epoch and epoch's interaction with experimental map (Map 1 or Map 2), sex (female or male), and focus (inner or outer). The repeated measure epoch was found to be significant as was interaction effect epoch X map and epoch X focus. The interaction of epoch X sex was only marginally significant, but the three-way interaction effect epoch X map X sex was significant. The significant change of mean reaction time over the seven epochs indicated a general downward trend of times. Faster reaction times were associated with more successful search processing and indicated successful learning was generally taking place for subjects during this stage in the experiment. Plots for the learning curves illustrate this point (Figures 3a and 3b).

"Faster reaction times were associated with more successful search processing and indicted successful learning was generally taking place for subjects during this stage in the experiment."

As expected, the reaction time means for subjects who viewed Map 1 were relatively fast and defined relatively flat learning curves (Figure 3a). There was, however, a decrease in mean reaction time from the first to the last epoch for both female inner focus (2023 ms to 1565 ms) and outer focus (1778 ms to 1548 ms) cities and male inner focus (1713 ms to 1365 ms) and outer focus (1582 ms to 1323 ms) cities. Note that the reaction time means for male subjects viewing Map 1 were faster than those of female subjects over the seven search tasks' epochs and that times for outer focus cities were faster than inner focus cities for both sexes.

As expected, the reaction time means for subjects who viewed Map 2 were relatively slow and defined relatively steep learning curves (Figure 3b). There was a relatively large decrease in mean reaction time from the first to the last epoch for both female inner focus (3359 ms to 2204 ms) and outer focus (2836 ms to 1766 ms) cities and male inner focus (4099 ms to 2427 ms) and outer focus (3050 ms to 2284 ms) cities. Note that the reaction time means for female subjects viewing Map 2 were much faster than those for male subjects over the seven search task epochs and that times for outer focus cities were faster than inner focus cities for both sexes. Note also that the means for the seventh Map 2 epochs were still slower than the first Map 1 epochs for all but the female outer focus category.

"Male subjects were faster for the Map 1 category, and female subjects were faster for the Map 2 category."

Between-subjects effects were computed to complement the repeated measure analysis by averaging reaction times over the seven epochs and using this average as the dependent variable (Table 1). The between-subject effects indicated the main effect map was significant, as was the main effect focus, but the main effect sex was only marginally significant. The interaction effect map X sex was also significant. The category means for these effects illustrate the differences (Figure 4). As expected, Map 1 subjects had the faster mean reaction time (Figure 4a). Reaction times for outer focus cities were also found faster than inner focus cities (Figure 4b). A more complex pattern related to sex that parallels the learning curves shown in Figure 3 was revealed by the significant interaction effect map X sex (Figure 4c). Male subjects were faster for the Map 1 category, and female subjects were faster for the map 2 category.

Within Subject Effects		
Repeated or Interaction Effect	F-Value	Probability of > F
Epoch	51.2	0.000
Epoch X Map	24.4	0.000
Epoch X Sex	1.9	0.079
Epoch X Focus	3.4	0.004
Epoch X Map X Sex	2.5	0.027
Epoch X Map X Focus	1.8	0.106
Epoch X Sex X Focus	0.7	0.610
Between Subject Effects		
Main or Interaction Effect	F-Value	Probability of > F
Map	144.5	0.000
Sex	3.2	0.078
Focus	5.2	0.024
Map X Sex	16.4	0.000
Map X Focus	2.1	0.154
Sex X Focus	0.0	0.959

Table 1. Within and between subject effects comparing Map 1 and Map 2 search times.

Discussion

It is not possible to know the exact learning processes being used by subjects by considering the reaction time patterns provided by the learning curves. Differences in the mean reaction times can, however, reveal difference patterns among the epoch categories and between map, sex, and focus categories.

A comparison of the performances of Map 1 and Map 2 subjects verified performance differences related to processing familiar versus unfamiliar named cities. The much lower mean reaction time values for subjects processing Map 1 indicated they already had some advantage when they started the experiment. This is reflected by the average Epoch 1 reaction time for Map 1 (1774 ms) versus Map 2 (3336 ms). As expected, prior knowledge of the names and locations of the cities appeared to significantly aid the Map 1 searches. The Epoch 7 mean reaction time was still considerably lower for Map 1 subjects (1453 ms) versus Map 2 subjects (2170 ms). The relatively flat slopes of the learning curves for Map 1 subjects also supported the expected effect of prior knowledge (Figure 3a). The relatively small improvement in mean reaction time for Map 1 subjects over the seven epochs suggested they did not learn much new information during the experiment.

Males showed a time advantage performing the search task with Map 1. This agrees with the notion that males may have more geographic knowledge related to U.S. city locations stored in their memories (Zinser, Palmer, and Miller 2004). Females, however, showed a larger time advantage performing the search task with Map 2. This agrees with the argu-

“This agrees with the argument from the hunter-gatherer theory that females are naturally better at learning and recalling the locations of objects . . .”

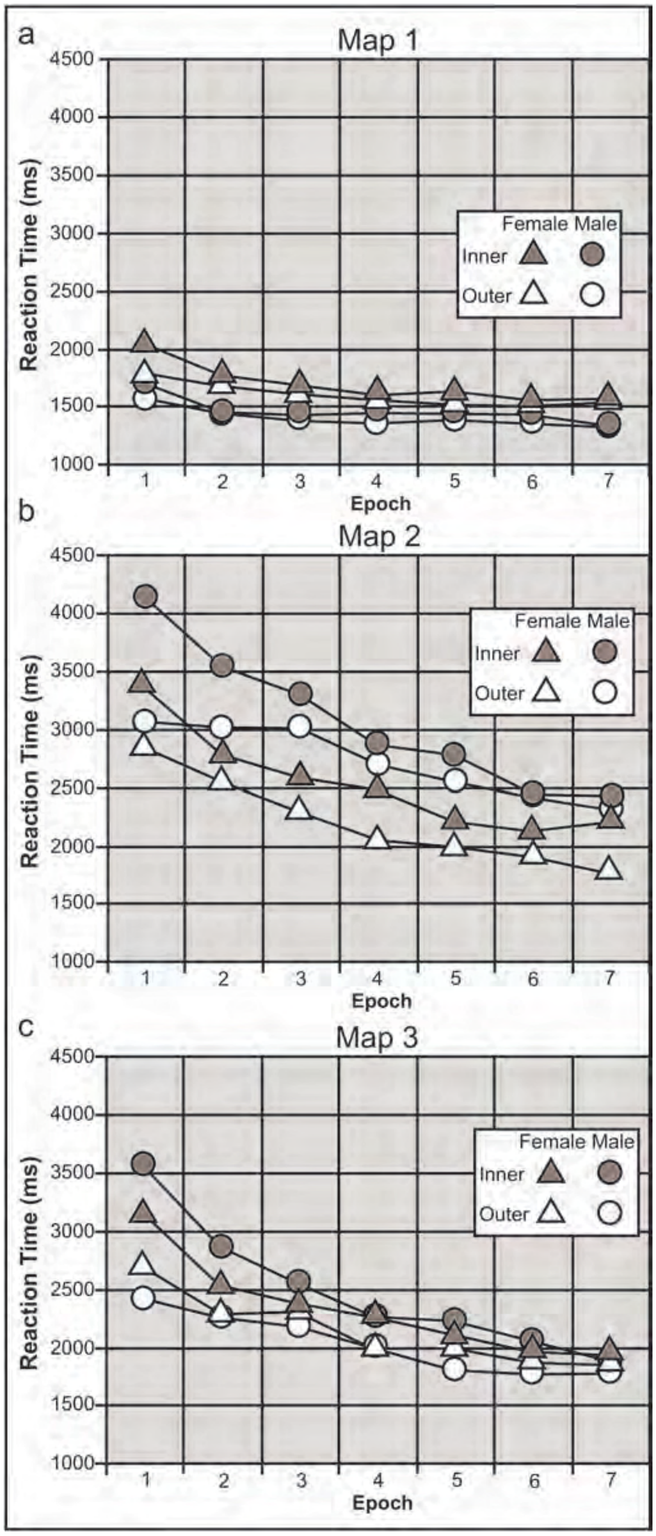

Figure 3. Inner and outer learning curves for female and male subjects for the experimental conditions using Map 1 (a), Map 2 (b), and Map 3 (c). Reaction time indicates the relative difficulty of the search and a decrease of reaction times over the epochs indicates learning.

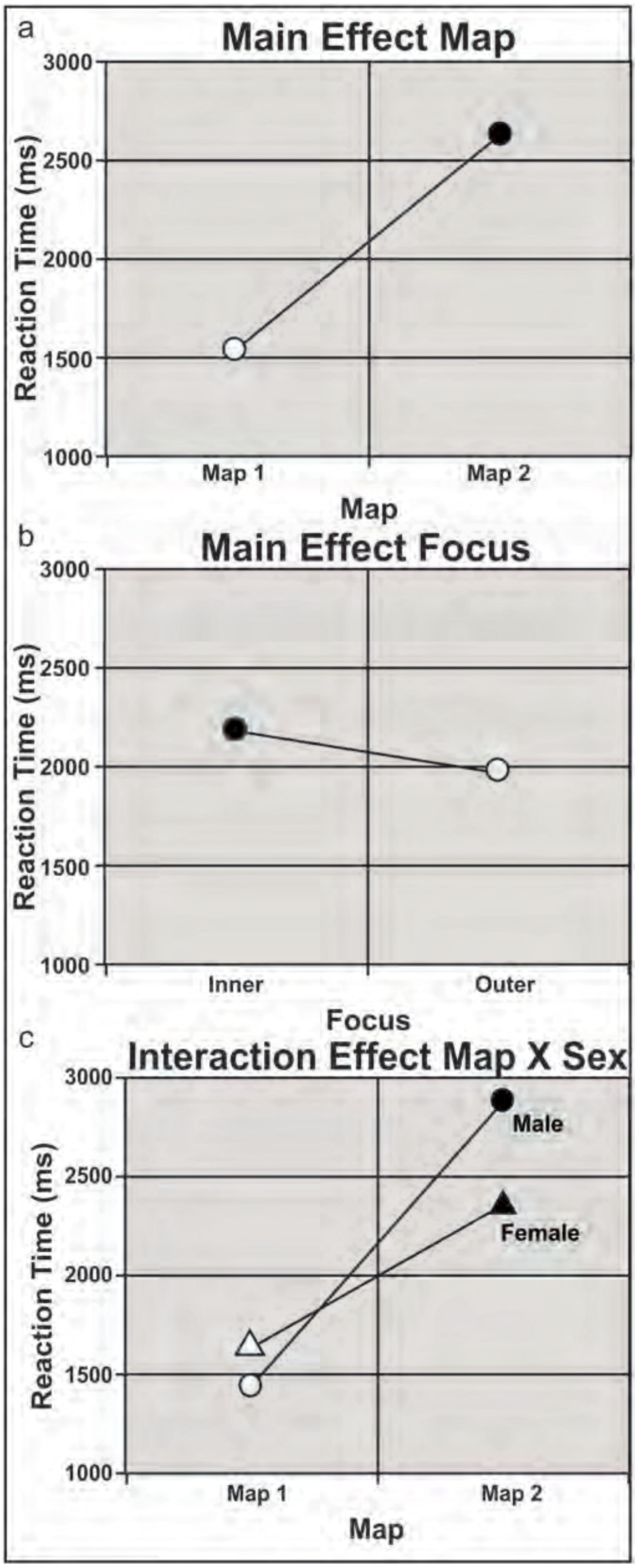

Figure 4. Category means for significant between-subject main and interaction effects for the repeated measure analysis of reaction times for Map 1 and Map 2 subjects.

ment from the hunter-gatherer theory that females are naturally better at learning and recalling the locations of objects (Silverman, Choi, and Peters 2007). Zinser, Palmer, and Miller (2004) would argue that the differences in the sexes would disappear if both exerted more effort to be prepared. Females would need to be more interested in the geographic information associated with the real cities to inspire additional learning that could aid their searches for those real cities on Map 1. Since males have no prior knowledge of the hypothetical cities on Map 2, they need to spend more time than females studying Map 2 so they can overcome the natural advantage females have learning the locations of objects in space.

"Subjects also tended to perform the search task significantly faster when the target city was in a peripheral region."

Subjects also tended to perform the search task significantly faster when the target city was in a peripheral region. This supports the arguments made by Huttenlocher, Hedges, and Duncan (1991) that categorical spatial information can have a significant influence on performance.

Some of the improvement for all subjects could be related to factors unrelated to knowledge of city names and locations. As the number of trials increased, more successful strategies for searching the map could be developed and subjects could improve physical skills related to moving, aiming, and clicking the mouse.

Results: Map 2 versus Map 3

Map 2 and Map 3 subjects viewed the same novel city names on their maps that should not be connected to any useful prior knowledge. The two maps, however, presented the cities with different spatial distributions. If a clustered distribution is harder or easier to learn for either sex, the differences should be reflected in the learning curves for the maps.

Repeated Measure Analysis

Another repeated measure analysis was performed, comparing the Map 2 and Map 3 data (Table 2). The repeated measure epoch was found to be significant as was the interaction effect epoch X focus. The interaction effect epoch X map was not significant and interaction effect epoch X sex was marginally significant. One three-way interaction effect, epoch X sex X focus, was also interestingly significant. The significant change of mean reaction time over the seven epochs indicated a general downward trend of times. Plots for the learning curves illustrate this point (Figure 3b and 3c).

"Males showed the worst performance searching for inner focus cities on both maps, but showed a marked improvement searching for outer focus cities on Map 3 compared to Map 2."

The reaction time means for Map 3 subjects indicated a relatively large decrease in mean reaction time from the first to the last epoch for both female inner focus (3136 ms to 1935 ms) and outer focus (2687 ms to 1823 ms) cities and male inner focus (3566 ms to 1881 ms) and outer focus (2418 ms to 1784 ms) cities. Note that the average Map 3 subjects (2952 ms to 1856 ms) were performing faster searches than the average Map 2 subjects (3336 ms to 2170 ms).

The most distinctive pattern for the learning curve means for Map 2 was that female subjects were generally faster than male subjects (Figure 3b). The most distinctive pattern for the learning curve means for Map 3 was that outer focus cities were generally found faster than inner focus cities (Figure 3c). The learning curve patterns for female subjects were very similar for Map 2 and Map 3 searches. This suggests female subjects may have used a similar search strategy with both maps. In both cases, outer focus cities were generally found faster than inner focus cities. The learning curves for male subjects revealed a different pattern. Males showed the worst performance searching for inner focus cities on both maps, but showed a marked improvement searching for outer focus cities on Map 3

Within Subject Effects		
Repeated or Interaction Effect	F-Value	Probability of > F
Epoch	80.6	0.000
Epoch X Map	1.2	0.336
Epoch X Sex	2.0	0.077
Epoch X Focus	4.9	0.000
Epoch X Map X Sex	1.1	0.367
Epoch X Map X Focus	1.0	0.447
Epoch X Sex X Focus	3.0	0.009
Between Subject Effects		
Main or Interaction Effect	F-Value	Probability of > F
Map	13.3	0.000
Sex	6.9	0.010
Focus	10.0	0.002
Map X Sex	5.7	0.019
Map X Focus	0.0	0.958
Sex X Focus	0.4	0.531

Table 2. Within and between subject effects comparing Map 2 and Map 3 search times.

compared to Map 2. For Map 3, the male mean outer focus reaction times were equal to or faster than comparable female means (Figure 3c).

The between-subjects analysis indicated the main effects map, sex, and focus were all significant as was the interaction effect map X sex (Table 2). The means for these effects illustrate the categorical differences (Figure 5). The reaction time mean for Map 3 indicated these subjects had a significant advantage over Map 2 subjects (Figure 5a). Female subjects also responded significantly faster than male subjects (Figure 5b), and the outer focus cities were responded to faster than inner focus cities (Figure 5c). The significant interaction effect map X sex indicated females and males responded differently to the two maps. Female subjects responded consistently to the two maps. Male subjects were relatively slow when responding to Map 2 and much faster and approximately equal to female subjects when responding to Map 3 (Figure 5d).

"This suggests female subjects were using a more effective encoding process than males and used it more successfully with both maps . . ."

Discussion

It is clear that subjects generally searched Map 3 more efficiently than Map 2 (Figure 5a). The only difference in the two maps was the spatial distribution of the cities. This had to play a key role in explaining the performance difference. The patterns of the learning curves do not allow one to determine the exact processes subjects used to search the maps and implicitly learn the locations of the cities, but one can easily see the significant decrease of mean reaction time over the epochs and the categorical differences in the reaction time patterns for the main effects (Figure 3). Female subjects generally had consistent reaction time patterns for the

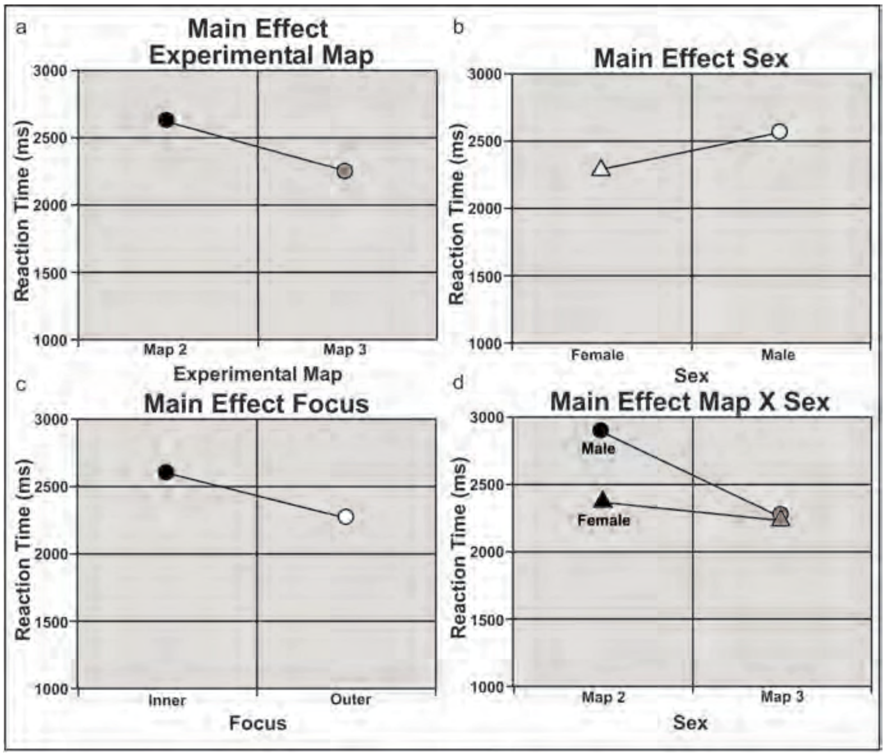

Figure 5. Category means for significant between-subject main and interaction effects for the repeated measure analysis of reaction times for Map 2 and Map 3 subjects.

two maps and significantly outperformed male subjects (Figure 5b). This suggests female subjects were using a more effective encoding process than males and used it successfully with both maps (Figure 5d). Based on the literature, one possible explanation is that they were using a process that encoded categorical information (Frings et al. 2006). Male subjects were consistently slower than female subjects searching Map 2, but male subjects performed better with Map 3, particularly with outer focus cities (Figure 5d). Subjects were generally able to find outer focus cities faster than inner focus cities (Figure 5c).

"One does not have to recall precisely where a city is, but just have enough spatial knowledge to guide attention to a place on the map with enough precision to be able to verify the name labeling the city."

Given Huttenlocher, Hedges, and Duncan's (1991) contention that people can learn both categorical and coordinate spatial information and combine the two types to estimate a location, why might there be a difference in female and male reaction time learning curves? If female subjects tended to encode categorical information and male subjects tended to encode coordinate information, this could explain some sex differences. For example, female subjects performed the search task with Map 2 significantly faster than male subjects over the seven epochs (Figure 3b). This could simply be because categorical information is easier to retain in memory than coordinate information (van der Ham et al. 2007). Because male subjects are learning coordinate information, they will need more time to retain enough of this type of information to equal the performance of female subjects with categorical information. This assumes that having both types of spatial information, once encoded, will aid subsequent search tasks. Evidence from Map 1 would seem to support this assumption (Figure 3a). It also seems reasonable to assume categorical spatial knowledge would be sufficient for doing the search task. One does not have to recall precisely where a city is, but just have enough spatial knowledge to guide attention to a place on the map with enough precision to be able to verify the name labeling the city. Knowing that the city is in the southwest corner of the map may be all one needs to quickly find a city.

The relative clustering of cities on Map 2 and Map 3 (Figures 2b and 2c) impacted male performance but did not seem to affect female performance (Figures 3b and 3c). Females were apparently using the same process with both maps. If the hunter-gatherer theory is correct, most female subjects will encode categorical information, for instance, verbal descriptions of city locations (Silverman, Choi, and Peters 2007). Since categorical codes are by nature not providing precise information, the relative clustering of the cities on the two maps may not have a great impact on this type of processing.

The results for Map 2 and Map3 suggested Male subjects did not have consistent learning curves and performed the search task better with Map 3 (Figures 3b and 3c). Why did the clustering of cities on Map 3 improve Male performance? It could be that the obvious cluster of cities in the center of the map focused attention there enough to inspire Male subjects to encode and use more information that is categorical. The Male subjects were able to make a quick distinction between cities in the cluster (Inner Focus) and cities on the periphery (Outer Focus). Once that initial categorization was made, the Males learned the Outer Focus cities more efficiently than the Inner Focus cities. This might be due to the larger number of Inner Focus cities in the central cluster compared to the smaller number of Outer Focus cities. The general trend showing that Males learned the Map 3 cities less efficiently than Females could be explained by Males' lack of preparedness using categorical codes to encode location (Zinser et al. 2004). By the seventh Epoch, however, the Males were able to adapt to the new strategy and came close to reaching parity with Females (Figure 3c).

"Why did the clustering of cities on Map 3 improve Male performance?"

Results: Spatial Location Error

The final stages in the experiments, following the learning stages, involved the subjects reconstructing the distribution of cities on the maps they had viewed. The coordinate data were averaged over the subjects and the mean cognitive city locations were represented for all map categories, along with the actual city locations for both sex categories (Figures 6, 7, and 8). The lines connecting the cognitive and physical locations represent mean location errors. The differences between physical and mean cognitive locations are relatively small for Map 1 subjects and not oriented in a consistent pattern. Mean errors appear to be particularly low for cities located along the coastline for female subjects and otherwise small and evenly distributed (Figure 6a). Male subjects appear to generally have lower mean errors for peripheral locations and higher, but still small, mean errors for cities that are centrally located (Figure 6b).

A different pattern is evident for Map 2 subjects (Figure 7). Mean location errors were relatively large throughout the maps and generally were oriented in consistent patterns. Cognitive locations tended to be more centrally located relative to their physical counterparts. Mean location errors generally appeared to be smaller for Map 2 female subjects (Figure 7a) compared with Map 2 male subjects (Figure 7b).

Map 3 subjects did visual searches with a map that had a definite cluster of cities. Location errors for cities outside the cluster were oriented toward the cluster with cognitive locations being closer to the cluster than their physical counterparts. The cluster of cities, as represented by cognitive locations, appeared to have been shifted northwest for both female (Figure 8a) and male (Figure 8b) subjects.

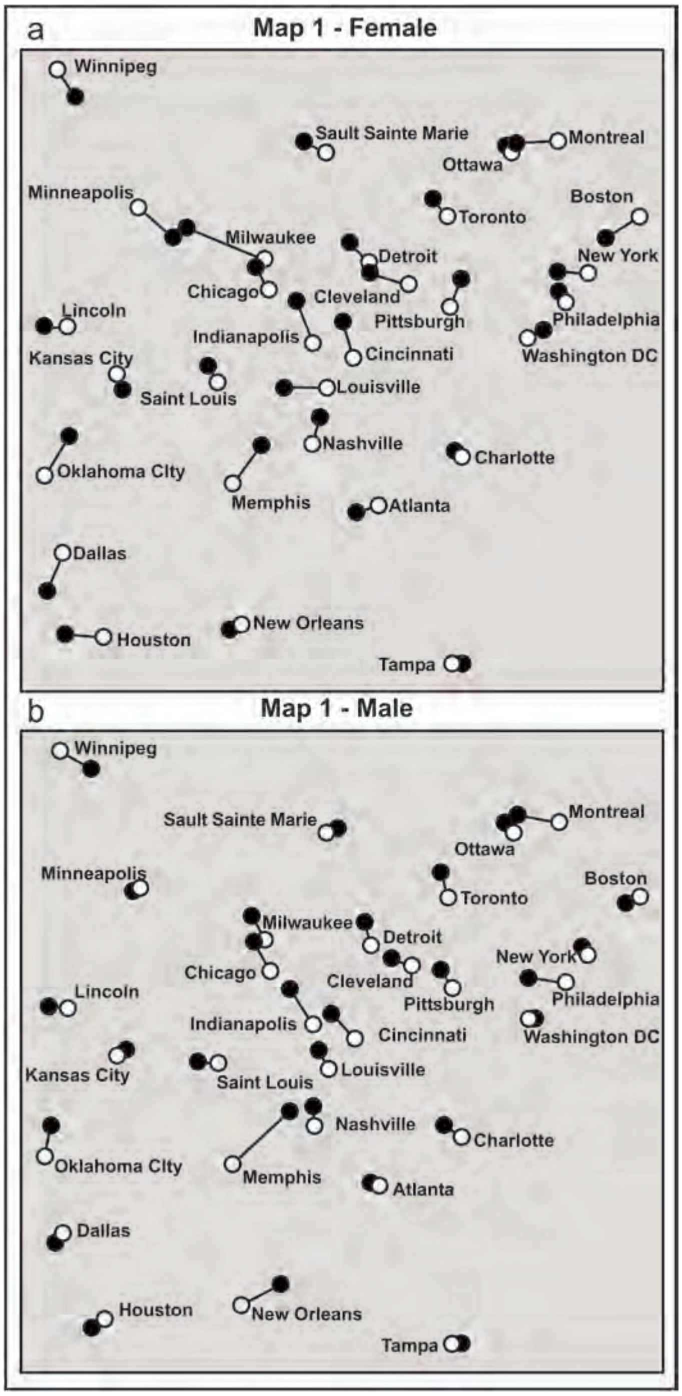

Figure 6. Physical (white) and cognitive (black) locations for the Map 1 cities for female (a) and male (b) subjects.

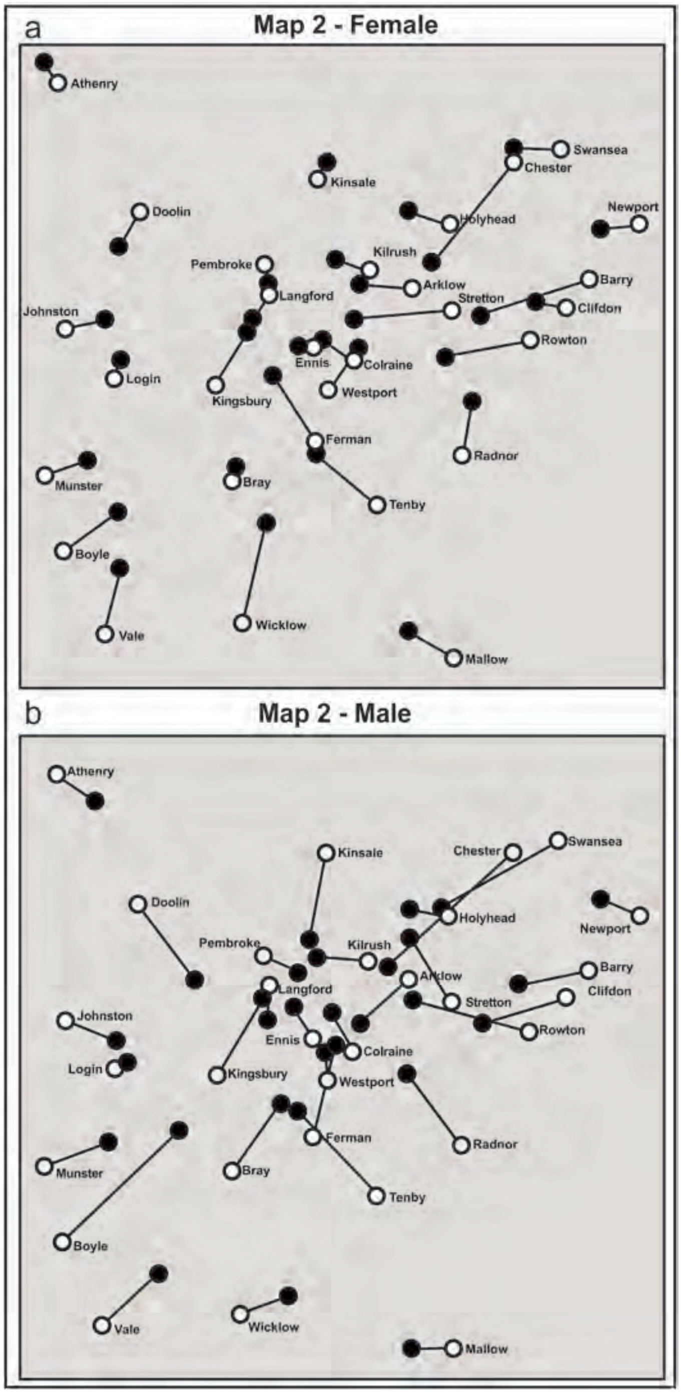

Figure 7. Physical (white) and cognitive (black) locations for the Map 2 cities for female (a) and male (b) subjects.

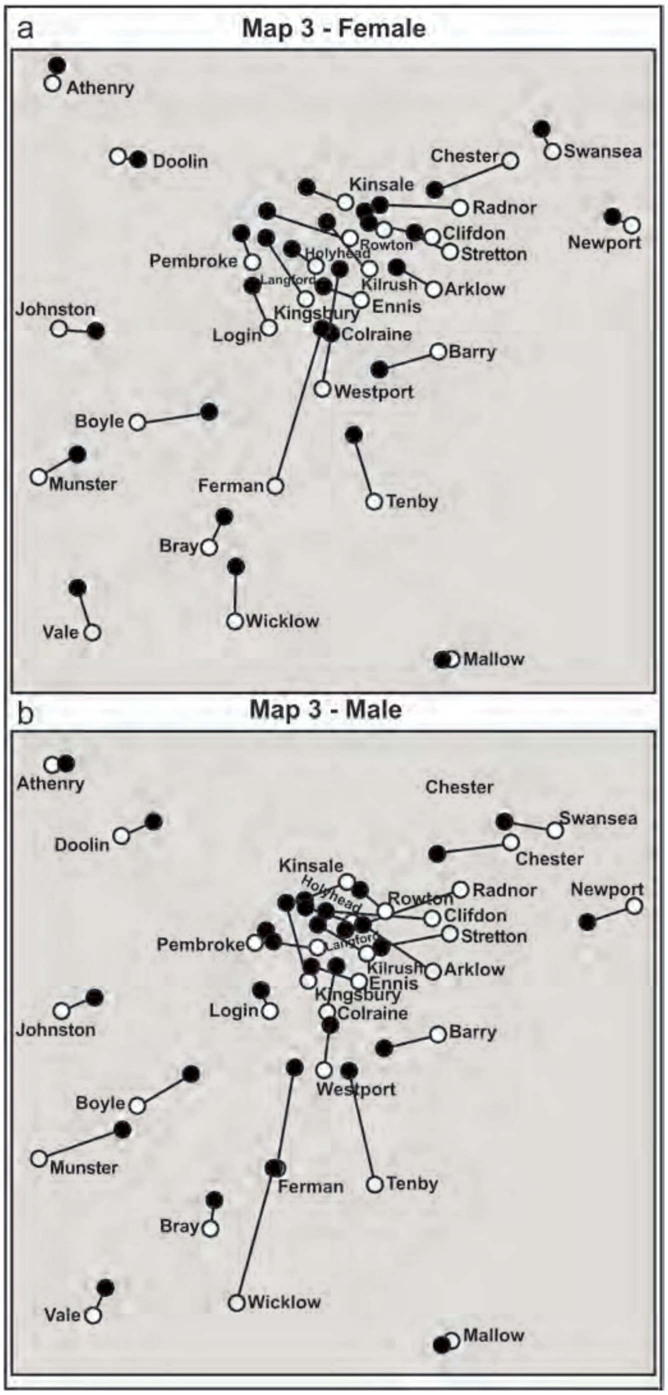

Figure 8. Physical (white) and cognitive (black) locations for the Map 3 cities for female (a) and male (b) subjects.

Euclidean Regressions
Separate Euclidean regressions were performed for the female and male mean city location data related to Map 1, Map 2, and Map 3 subjects (Figures 6, 7, and 8). For all regressions, the dependent space was represented by the cognitive locations for cities, and the independent space was represented by the physical locations for cities (Friedman and Kohler 2003). The horizontal shift, vertical shift, scale change, and rotation needed to achieve a best fit between the dependent and independent spaces are reported in Table 3.

The horizontal shift and vertical shift parameters indicate the translation needed to shift the physical locations of cities to best align them with the mean cognitive locations. A value of 0.0 would indicate no shift change was required for the horizontal or vertical axis. These parameters support the visual impression provided by Figures 6, 7, and 8 with data for Map 1 requiring the least adjustment and the data for Map 2 requiring the most adjustment (Table 3). Males had a small advantage for Map 1 and females had a larger advantage on Map 2 and Map 3.

The scale parameters indicate the scale change needed to expand or contract the physical space to best align it with the cognitive space. A parameter equal to 1.0 would indicate no change. These parameters show the same pattern with values for Map 1 indicating small contractions and values for Map 2 indicating the most required contraction. The required scale change was the same for female and male Map 1 subjects while female subjects had the advantage for Map 2 and Map 3 (Table 3).

The rotation parameters indicate the number of degrees the physical spaces must be rotated to align them with the cognitive spaces. These values were small (< 3°) for all map and sex combinations (Table 3). The r^2 values for the Euclidean regressions were relatively high for all the analyses. The best fit was for Map 1 male subjects (r^2=0.99) and the lowest fit was for Map 2 male subjects (r^2=0.91) (Table 3).

"This result supports other studies that have argued that prior knowledge enhances the performance of spatial tasks and learning processess . . ."

Discussion
It should not be surprising to find that Map 1 subjects recalled city locations more accurately than Map 2 or Map 3 subjects. This result supports other studies that have argued that prior knowledge enhances the performance of spatial tasks and learning processes (Lloyd 1988; Kulhavy et al. 1993; Schwartz et al. 1998). The sex differences apparent in the aggregated cognitive maps also support results previously reported in the literature.

Parameters	Map 1		Map 2		Map 3	
	Female	Male	Female	Male	Female	Male
Horizontal Shift	-4.76	<u>0.46</u>	<u>75.09</u>	120.87	<u>34.29</u>	55.54
Vertical Shift	8.24	<u>3.37</u>	<u>55.53</u>	106.76	<u>29.35</u>	51.55
Scale	0.98	0.98	0.81	0.75	0.88	0.83
Rotation	0.94	0.68	0.21	2.43	2.06	2.50
r^2	0.98	<u>0.99</u>	<u>0.96</u>	0.91	<u>0.95</u>	0.94

*Underlined table values indicate a female or male advantage on that parameter. Ideal values for horizontal shift, vertical shift, and rotation are 0.0. Ideal values for scale and r^2 are 1.0.

*Table 3. Summary of Euclidean regression results for map and sex combinations using average cognitive map city locations. The dependent space was always the cognitive locations of the cities and the independent space of their physical locations.**

Male subjects having a small advantage processing Map 1 supports the notion that males generally have more interest in geographic information, and this extra attention provides useful prior knowledge when searching for well-known cities (Zinser, Palmer, and Miller 2004). Female subjects having a larger advantage processing Map 2 supports the frequent finding that females perform significantly better than males on location memory tasks (Silverman and Eals 1992; Neave et al. 2005). Perhaps the most interesting reaction time comparison for female and male subjects was found for the Map 3 searches. The overall mean reaction time was similar for female (2229 ms) and male (2256 ms) subjects (Figure 5d), but the learning curve patterns were not the same for inner and outer focus cities (Figure 3c). Male subjects (3566 and 2418 ms) had a greater difference in mean reaction time than female subjects (3136 and 2687 ms) for Epoch 1, but differences for both male (1880 and 1784 ms) and female (1935 and 1823 ms) subjects had nearly vanished by Epoch 7, with males having a slight advantage. Since female subjects outperformed male subjects doing searches of Map 2 and the same false names were used on both maps, the clustering of cities must have inspired the male subjects' improving reaction time performance.

"This would indicate male subjects had learned to do the search task as fast as the female subjects but lagged behind in having an equally accurate cognitive map encoded through implicit learning."

Although male subjects had achieved reaction time parity with female subjects by Epoch 7, the accuracy maps (Figure 8) and Euclidean regressions for Map 3 indicated a female superiority. This would indicate male subjects had learned to do the search task as fast as the female subjects but lagged behind in having an equally accurate cognitive map encoded through implicit learning. Although male subjects appeared to be using a different process for doing the search task with Map 2 and Map 3, it is also possible male subjects may have used the same strategy processing Map 2 and Map 3, and the clustering of cities on Map 3 allowed them to process the information faster. In any event, the accuracy advantage for Female Map 2 and Map 3 subjects offers support for the superior location memory hypothesis for females (Silverman, Choi, and Peters 2007).

CONCLUSIONS

The literature indicates that asymmetrical brains should be an advantage in spatial cognition because they provide cognitive processing abilities that can be adapted to a variety of situations when learning spatial knowledge (Huttenlocher, Hedges, and Duncan 1991). Specifically, asymmetrical brains allow relationships among objects in space to be represented as both category information and coordinate information. The degree to which someone uses these alternate methods to acquire information could affect the nature of his/her cognitive map[s]. Cartographers might be interested in who uses these learning strategies and when they use them as they consider constructing a map that will be used to enhance learning.

"This research also tested the hypotheses that performance would be influenced by whether or not the map features were familiar (prior knowledge, where map features were located in the visual field (center versus periphery), and how map features were distributed (dispersed or clustered)."

An individual may not consciously decide to encode either categorical or coordinate information, but could spontaneously encode both types. Based on the literature, one possible explanation for the results is that people may have conscious or unconscious preferences toward a given encoding process that could affect their processing of spatial information (Choi et al. 2006). Based on research in cognition and evolutionary biology, the current research tested the hypothesis that males and females would tend to utilize different cognitive processes when learning spatial information from maps, and those differences would affect map-reading performances (Zinser, Palmer, and Miller 2004; Silverman and Eals 1992). Anyone who teaches with maps, uses maps to communicate ideas to groups of experts or novices, or designs Web pages that include maps might find this notion interesting. Anyone concerned with the degree of participation of seventh and eighth grade females and males in the National Geographic's

Geography Bee might be interested in studies that address the causes of individual differences (Hardwick et al. 2000). This research also tested the hypotheses that performance would be influenced by whether or not the map features were familiar (prior knowledge), where map features were located in the visual field (center versus periphery), and how map features were distributed (dispersed or clustered).

Three general conclusions can be made from the analyses of performance. First, it is clear from the results of the search portion of the experiment that learning did occur through the visual search task. All subject groups for all map conditions significantly improved their times from Epoch 1 to Epoch 7 without a decline in accuracy. It was expected that there would be greater improvement for the Map 2 and Map 3 conditions because those subjects started with little prior knowledge. (They were given two minutes to examine the map before the search task began.) It was, likewise, expected that the subjects who viewed Map 1 would demonstrate less improvement over the seven epochs because they started with substantial prior knowledge. (They viewed a map of a portion of North America with well-known cities.) The results supported both of these expectations.

The cognitive mapping results also showed that learning occurred. As expected, the positional error associated with the recall of Map 2 and Map 3 locations was greater than that of Map 1 (Figures 6, 7, and 8). The errors for Map 2 and Map 3, however, were clearly not the result of "guessing." The general patterns of the cognitive maps were correct; for example, peripheral cities were located on the periphery, central cities were located in the center, eastern cities were located in the east, northern cities were located in the north, etc. Prior knowledge provided the Map 1 subjects with a significant advantage, but considerable locational knowledge was obtained by the Map 2 and Map 3 subjects through learning.

Second, it is clear from the reaction time and location accuracy results that the average male and female experimental subjects performed differently. Cartographers should be interested in the nature of this difference as they design their maps for specific audiences. The apparent contradiction in the literature that suggests males perform better on tests of specific geographic knowledge (Dabbs et al. 1998; Nelson, Aron, and Poole 1999), and females have a better memory for the locations of objects in space (Silverman, Choi, and Peters. 2007; Voyer et al. 2007) is illustrated in the experimental data (Figures 4 and 5). There may be no contradiction if one considers the timing of the learning. The typical male is thought to perform better encoding coordinate information, and this process is more difficult to use effectively (Van der Ham et al. 2007). If males are forced to use a categorical style of coding or they do not have sufficient time to learn the coordinate information, they will be disadvantaged. Fitting this expectation, males performed the search task better when they had prior knowledge for well-known cities. The typical female is thought to learn spatial information by encoding categorical information, and this is less difficult to encode and use effectively. If females are forced to compete with a coordinate style over a long period of time, they should be disadvantaged. Fitting this expectation, females performed the search task much better than males under conditions of little prior knowledge and a novel map. Differences between the sexes follow this pattern for both the reaction time data (Figures 4 and 5) and for the comparisons of recalled maps (Table 3).

Third, the nature of the learned map significantly affected the learning performance of the subjects. Although reaction times significantly decreased over the seven learning epochs for all maps, the learning curves were flatter for Map 1 subjects and steeper for Map 2 and Map 3 subjects

"If males are forced to use a categorical style of coding or they do hot have sufficient time to learn the coordinate information, they will be disadvantaged."

"If females are forced to compete with a coordinate style over a long period of time, they should be disadvantaged."

(Figure 3). This is a strong indication that the search tasks were relatively easy with a familiar map and relatively difficult with a novel map. Subjects also recalled city locations more accurately for Map 1 than for Map 2 or Map 3 (Table 3). Significant differences for reaction time and location accuracy comparing Map 2 and Map 3 also indicated the distribution of cities on the maps affected subjects' performances (Figure 4 and Table 3).

"One could also have one group of subjects learn the cities explicitly and another set of subjects learn the cities implicitly and compare their relative success."

The current study used subjects that had enrolled in geography classes to acquire both female and male subjects that had expressed an interest in geography. This increased the likelihood that the subjects would have prior knowledge for U.S. cities. This could also mean the subjects also had better spatial abilities than average males and females (Casey 1996; Lloyd and Bunch 2005). Future studies might compare performance for a sample of geographers and non-geographers to explicitly test for the effect of prior knowledge.

Future studies could also focus on explicit learning processes and directly compare female and male cognitive maps for subjects who were given instructions to use categorical or coordinate encoding strategies. This would provide comparisons of performances for females and males who were consciously trying to use a common learning strategy. One could also have one group of subjects learn the cities explicitly and another set of subjects learn the cities implicitly and compare their relative success.

NOTES

[1]The terms categorical and coordinate information are used here to conform to the terms used by Kosslyn (1987) as he related learning to encoding spatial information into memory. Researchers have also made similar binary distinctions using terms such as verbal versus visual information, propositions versus imagery, or route versus survey perspectives (Kosslyn and Pomerantz 1977; Bunch and Lloyd 2006; Péruch et al. 2006).

[2]These three examples were selected because they generally should be found on reference maps commonly available for public use and because some were selected for use in the current study. They are not the only potentially important reference frames. Important cities that are not home locations, rivers, and physiographic regions are other examples of point, line, and area reference frames. Also important on some maps are graticules that can be used to define locations with some degree of precision.

REFERENCES

Adam, Jos J., Bernhard Hommel, and Carlo Umiltà. 2003. Preparing for perception and action (I): The role of grouping in the response-cuing paradigm. *Cognitive Psychology* 46:302-358.

Annett, Marian. 2002. *Handedness and brain asymmetry: The right-shift theory*, 2d rev. ed. Hove, UK: Psychology Press.

Barkley, Cynthia L., and Kara I. Gabriel. 2007. Sex differences in cue perception in a visual scene: Investigation of cue type. *Behavioral Neuroscience* 121:291-300.

Beatty, William W., and J.A. Bruellman. 1987. The absence of gender differences in memory for map learning. *Bulletin of the Psychonomic Society* 25:238-239.

Beatty, William W., and Alexander I. Tröster. 1987. Gender differences in geographical knowledge. *Sex Roles* 16:565-590.

Bein, Frederick L. 1990. Baseline geography competency test: Administered in Indiana universities. *Journal of Geography* 89:260-265.

Brennan, Nicole Gallinaro, and Robert Lloyd. 1993. Searching for boundaries on maps: The cognitive process. *Cartography and Geographic Information Science* 20:222-236.

Bunch, Rick L., and Robert Earl Lloyd. 2000. The search for boundaries on choropleth maps: Color processing and map pattern effects. *Cartography and Geographic Information Science* 27:15-30.

——. 2006. The cognitive load of geographic information. *The Professional Geographer* 58:209-220.

Butler, Tracy, Julianne Imperato-McGinley, Hong Pan, Daniel Voyer, Juan Cordero, Yuan-Shan Zhue, Emily Stern, and David Silbersweig. 2006. Sex differences in mental rotation: Top-down versus bottom-up processing. *NeuroImage* 32:445-456.

Casey, M. Beth. 1996. Understanding individual differences in spatial ability within females: A nature/nurture interaction framework. *Developmental Review* 16:241-260.

Choi, Jean, Erin McKillop, Michael Ward, and Natasha L'Hirondelle. 2006. Sex-specific relationships between route-learning strategies and abilities in a large-scale environment. *Environment and Behavior* 38:791-801.

Choi, Jean, and Irwin Silverman. 2003. Processes underlying sex differences in route-learning strategies in children and adolescents. *Personality and Individual Difference* 34:1153-1166.

Coluccia, Emanuele, Giorgia Iosue, and Maria Antonella Brandimonte. 2007 The relationship between map drawing and spatial orientation abilities: A study of gender differences. *Journal of Environmental Psychology* 27:135-144.

Couclelis, Helen, Reginald Golledge, Nathan Gale, and Waldo Tobler. 1987. Exploring the anchor-point hypothesis of spatial cognition. *Journal of Environmental Psychology* 7:99-122.

Cross, John A. 1987. Factors associated with students' place location knowledge. *Journal of Geography* 86:59–63.

Dabbs, James M., Jr., E-Lee Chang, Rebecca A. Strong, and Rhonda Milun. 1998. Spatial ability, navigation strategy, and geographic knowledge among men and women. *Evolution and Human Behavior* 19:89-98.

Danner, Unna L., Henk Aarts, and Nanne K. de Vries. 2007. Habit formation and multiple means to goal attainment: Repeated retrieval of target means causes inhibited access to competitors. *Personality and Social Psychology Bulletin* 33:1367-1379.

Eals, Marion, and Irwin Silverman. 1994. The hunter-gatherer theory of spatial sex differences: Proximate factors mediating the female advantage in recall of object arrays. *Ethology and Sociobiology* 15:95-105.

Ecuyer-Dab, Isabelle, and Michèle Robert. 2004a. Have sex differences in spatial ability evolved from male competition for mating and female concern for survival? *Cognition* 91:221-257.

——. 2004b. Spatial ability and home-range size: Examining the relationship in Western men and women (Homo sapiens). *Journal of Comparative Psychology* 118:217-231.

Enoch, Jay M. 1959. Effect of the size of a complex display upon visual search. *Journal of the Optical Society of America* 49:280-286.

Eve, Raymond A., Bob Price, and Monika Counts. 1994. Geographic illiteracy among college students. *Youth and Society* 25:408–427.

Friedman, Alinda, and Norman R. Brown. 2000a. Updating geographical knowledge: Principles of coherence and inertia. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 26:900-914.

——. 2000b. Reasoning about geography. *Journal of Experimental Psychology: General* 129:193-219.

Friedman, Alinda, and Bernd Kohler. 2003. Bidimensional regression: Assessing the configural similarity and accuracy of cognitive maps and other two-dimensional data sets. *Psychological Methods* 8:468-491.

Frings, Lars, Kathrin Wagner, Josef Unterrainer, Joachim Spreer, Ulrike Halsband, and Andreas Schulze-Bonhage. 2006. Gender related differences in lateralization of hippocampal activation and cognitive strategy. *NeuroReport* 17:417-421.

Griffin, Amy L., Alan M. MacEachren, Frank Hardisty, Erik Steiner, and Bonan Li. 2006. A comparison of animated maps with static small-multiple maps for visually identifying space-time clusters. *Annals of the Association of American Geographers* 96:740-753.

Halpern, Diane F. 2000. *Sex differences in cognitive abilities* Mahwah, NJ: Lawrence Erlbaum.

Hardwick, Susan W., Lydia L. Bean, Kathy A. Alexander, and Fred M. Shelley. 2000. Gender versus sex differences: Factors affecting performance in geographic education. *The Journal of Geography* 99:238-44.

Hawkes, Kristen. 1991. Showing off: tests of an hypothesis about men's foraging goals. *Ethology and Sociobiology* 12:29-54.

Henrie, Roger L., Robert H. Aron, Burton D. Nelson, and Debra A. Poole. 1997. Gender-related knowledge variations within geography. *Sex Roles: A Journal of Research* 36:605-623.

Hodgson, Michael E. 1998. What size window for image classification? A cognitive perspective. *Photogrammetric Engineering and Remote Sensing* 64:797-807.

Hugdahl, Kenneth, Tormod Thomsen, and Lars Ersland. 2006. Sex differences in visuo-spatial processing: An fMRI study of mental rotation. *Neuropsychologia* 44:1575-1583.

Huttenlocher, J., L.V. Hedges, and S. Duncan. 1991. Categories and particulars: Prototype effects in estimating spatial locations. *Psychological Review* 98:352-376.

Jacobs, Lucia F. 2003. The evolution of the cognitive map. *Brain, Behavior, and Evolution* 62:128-139.

——. 2006. From movement to transitivity: The role of hippocampal parallel maps in configural learning. *Reviews in Neuroscience* 17:99-109.

Jacobs, Lucia F., and Françoise Schenk. 2003. Unpacking the cognitive map: The parallel map theory of hippocampal function. *Psychological Review* 110:285-315.

Jager, G., and Albert Postma. 2003. On the hemispheric specialization for categorical and coordinate spatial relations: A review of the current evidence. *Neuropsychologia* 41:504-515.

Jones, C.M., V.A. Braithwaite, and S.D. Healy. 2003. The evolution of sex differences in spatial ability. *Behavioral Neuroscience* 117:403-11.

Kemmerer, David. 2006. The semantics of space: Integrating linguistic typology and cognitive neuroscience. *Neuropsychologia* 44:1607-1621.

Kimura, Doreen. 2000. *Sex and Cognition.* Cambridge: MIT Press.

Kosslyn, Stephen M., and James R. Pomerantz. 1977. Imagery, propositions, and form of internal representations. *Cognitive Psychology* 9:52-76.

Kosslyn, Stephen M. 1987. Seeing and imagining in the cerebral hemispheres: A computational approach. *Psychological Review* 94:148-175.

——, W. Thompson, D. Gitelman, and N. Alpert. 1989. Neural systems that encode categorical versus coordinate spatial relations: PET investigations. *Psychobiology* 26:333–347.

Kulhavy, R.W., K.A. Woodard, R.C. Haygood, and J.M. Webb. 1993. Using maps to remember text: An instructional analysis. *British Journal of Educational Psychology* 63:161-169.

Lawton, Carol A., and Janos Kallai. 2002. Gender differences in wayfinding strategies and anxiety about wayfinding: A cross-cultural comparison. *Sex Roles: A Journal of Research* 47:389-401.

Lee, Jongwon, and Robert S. Bednarz. 2005. Video analysis of map-drawing strategies. *Journal of Geography* 104:211-221.

Liben, L. 1995. Psychology meets geography: Exploring the gender gap on the National Geography Bee. *Psychological Science Agenda* 8:8–9.

Lloyd, Robert Earl. 1988. Searching for map symbols: The cognitive process. *American Cartographer* 15:363-377.

——, M. Hodgson, and M. Stokes. 2002. Visual categorization with aerial photographs. *Annals of the Association of American Geographers* 92:241-266.

Lloyd, Robert Earl. 2003. The interaction of biological and environmental effects on spatial abilities: A review. *Research in Geographic Education* 5:48-84.

——, and Rick L. Bunch. 2005. Individual differences in map reading spatial abilities using perceptual and memory processes. *Cartography and Geographic Information Science* 32:33-46.

——. 2008. Explaining map-reading performance efficiency: Gender, memory, and geographic information. *Cartography and Geographic Information Science* 35:171-202.

Lynch, Kevin. 1960. *The image of the city.* Cambridge: MIT Press.

Maccoby, Eleanor, and Carol Jacklin. 1974. *The psychology of sex differences* Stanford: Stanford University Press.

McBurney, Donald H., Steven J.C. Gaulin, Trishul Devineni, and Christine Adams. 1997. Superior spatial memory of women: Stronger evidence for the gathering hypothesis. *Evolution and Human Behavior* 18:165-174.

McGivern, Robert F., J. Patrick Huston, Desiree Byrd, Tina King, Greg J. Siegle, and Judy Reilly. 1997. Sex differences in visual recognition memory: Support for a sex-related difference in attention in adults and children. *Brain and Cognition* 34:323-336.

McGivern, Robert F., K.L. Mutter, Julie Anderson, Graham Wideman, Mark Bodnar, and Patrick J. Huston. 1998. Gender differences in incidental learning and visual recognition memory: support for a sex difference in unconscious environmental awareness. *Personality and Individual Diffe - ences* 25:223-232.

Miller, Geoffrey E. 2001. The mating mind: How sexual choice shaped the evolution of human nature. London: Vintage Press.

Montello, Daniel R., Kristin L. Lovelace, Reginald G. Golledge, and Carole M. Self. 1999. Sex-related differences and similarities in geographic and environmental spatial abilities. *Annals of the Association of American Geographers* 89:515-534.

Neave, Nick, Colin Hamilton, Lee Hutton, Nicola Tildesley, and Anne T. Pickering. 2005. Some evidence of a female advantage in object location memory using ecologically valid stimuli. *Human Nature* 16:146-163.

Nelson, Burton D., Robert H. Aron, and Debra A. Poole. 1999. Underprediction of female performances from standardized knowledge tests: A further example from the knowledge of geography test. *SexRoles* 41:529–540.

Newcombe Nora S., and Noelle Chiau-Ru Chiang. 2007. Learning geographical information from hypothetical maps. *Memory and Cognition* 35:895-909.

Nori, Raffaella, and Fiorella Giusberti. 2006. Predicting cognitive styles from spatial abilities. *American Journal of Psychology* 119:67-86.

Pasteur, Louis. 1874. *Works* Comptes Rendus de l'Académie des Sciences 1. Patrice Debré, Elborg Forster, trans. 2000. *Louis Pasteur*. Baltimore: Johns Hopkins Press.

Péruch, Patrick, Vanessa Chabanne, Marie-Pascale Nesa, Catherine Thinus-Blanc, and Michel Denis. 2006. Comparing distances in mental images constructed from visual experience or verbal descriptions: The impact of survey versus route perspective. *The Quarterly Journal of Experimental Psychology* 59:1950–1967.

Postma, Albert, and Bruno Laeng. 2006. New insights in categorical and coordinate processing of spatial relations. *Neuropsychologia* 44:1515-1518.

Proulx, Michael J., and Howard E. Egeth. 2008. Biased competition and visual search: the role of luminance and size contrast. *Psychological Research* 72:106-113.

Rybash, John M., and William J. Hoyer. 1992. Hemispheric specialization for categorical and coordinate spatial representations: A reappraisal. *Memory and Cognition* 20:271-276.

Saucier, Deborah M., Sheryl M. Green, Jennifer Leason, Alastair MacFadden, Scott Bell, and Lorin J. Elias. 2002. Are sex differences in navigation caused by sexually dimorphic strategies or by differences in the ability to use the strategies? *Behavioral Neuroscience* 116:403-410.

Schwartz, Neil H., Laurie H. Ellsworth, Lorraine Graham, and Bruce Knight. 1998. Accessing prior knowledge to remember text: A comparison of advance organizers and maps. *Contemporary Educational Psychology* 23:65-89.

Seligman, Martin E. P. 1970. On the generality of the laws of learning. *Psychological Review* 77:406-418.

Silverman, Irwin, J. Choi, A. Mackewn, M. Fisher, J. Moro, and E. Olshansky, E. 2000. Evolved mechanisms underlying wayfinding: Further studies on the hunter-gatherer theory of spatial sex differences. *Evolution and Human Behavior* 21:201-213.

——, Choi, Jean, and Michael Peters. 2007. The hunter-gatherer theory of sex differences in spatial abilities: Data from 40 countries. *Archives of Sexual Behavior* 36:261–268.

——, and Marion Eals. 1992. Sex differences in spatial abilities: Evolutionary theory and data. In *The adapted mind: Evolutionary psychology and the generation of culture.* Jerome H. Barkow, Leda Cosmides, and John Tooby, eds. New York: Oxford Press, 531-549.

Slotnick, Scott D., and Lauren R. Moo 2006. Prefrontal cortex hemispheric specialization for categorical and coordinate visual spatial memory. *Neuropsychologia* 44:1560–1568.

Stevens, Albert, and P. Coupe. 1978. Distortions in judged spatial relations. *Cognitive Psychology* 10:422–437.

Tottenham, Laurie Sykes, Deborah Saucier, Lorin Elias, and Carl Gutwin. 2003. Female advantage for spatial location memory in both static and dynamic environments. *Brain and Cognition* 53: 381-383.

Trojano, Luiji, Massimiliano Conson,, Raffaele Maffei, and Dario Grossi. 2006. Categorical and coordinate spatial processing in the imagery domain investigated by rTMS. *Neuropsychologia* 44:1569–1574.

Tversky, Barbara. 1981. Distortions in memory for maps. *Cognitive Psychology* 13:407-433.

Vallortigara, Giorgio, and Lesley J. Rogers. 2005. Survival with an asymmetrical brain: Advantages and disadvantages of cerebral lateralization. *Behavioral and Brain Sciences* 28: 575-633.

van der Ham, Ineke J.M., Richard J.A. van Wezel, Anna Oleksiak, and Albert Postma. 2007. The time course of hemispheric differences in categorical and coordinate spatial processing. *Neuropsychologia* 45:2492–2498.

van der Lubbe, Rob H.J., Marieke Schölvinck, J. Leon Kenemans, and Albert Postma. 2006. Divergence of categorical and coordinate spatial processing assessed with ERPs. *Neuropsychologia* 44:1547–1559.

Voyer, Daniel, Albert Postma, Brandy Brake, and Julianne Imperato-McGinley. 2007. Gender differences in object location memory: A meta-analysis. *Psychonomic Bulletin and Review* 14:23-38.

——, S. Voyer, S. and M.P. Bryden. 1995. Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin* 117:250–270.

Watson, N.V., and Doreen Kimura. 1991. Nontrivial sex differences in throwing and intercepting: Relation to psychometrically-defined spatial functions. *Personality and Individual Difference* 12:375-385.Wood, Clifford H. 1993. Visual search centrality and minimum map size. *Cartographica* 30:32-44.

Wolfe, Jeremy M., Todd S. Horowitz, Naomi Kenner, Megan Hyle, and Nina Vasan. 2004. How fast can you change your mind? The speed of top-down guidance in visual search. *Vision Research* 44:1411-1426.

Zinser, Otto, Debra L. Palmer, and Christy R. Miller. 2004. Site distance, gender, and knowledge of geographic sites. *Sex Roles* 51:661-686.

Results of the 2009 *Cartographic Perspectives* Readership Survey

Fritz Kessler

Amy Griffin

INTRODUCTION

Cartographic Perspectives (*CP*) publishes interesting and unique cartographically-related material from a diverse population of mapping enthusiasts. *CP* has been published three times a year since the journal's first issue appeared in 1989. This current issue marks *CP*'s sixty-third issue. By most measures in the print industry, this longevity should be cause for excitement. And publishing sixty-three issues is. However, as with all entities that persist through time, one should be introspective as to what makes the journal appealing and what is lackluster. This introspection is important so as to gauge the journal's health and make plans for a continued successful future. This article presents the results of a survey of NACIS members that was conducted in January 2009. The purpose of this article is to present and discuss the shared sentiments of NACIS members regarding *CP*, what the membership sees as *CP*'s strengths and weaknesses, and what new directions the membership would like to see the journal take in order to maintain its unique appeal.

DESIGNING THE QUESTIONS

At the fall NACIS meeting at Missoula, Montana, *CP*'s Editorial Board discussed ways in which the journal could be improved. Several ideas were floated before it became apparent that the board did not really understand what NACIS members thought about the journal. With this in mind, a readership survey was discussed as a way to gain insight into what you, as a NACIS member, feel about the journal. We decided that the survey would take place early in 2009 and discussed how the survey would be carried out. We decided that mailing the survey to NACIS members would be too slow and would reduce the number of respondents. We looked toward the Web as a friendlier and timelier delivery method for the survey, which we hoped would ultimately increase the number of respondents. With a response rate of 26.3 percent we believe the method of delivery we chose provided us with a solid sample of NACIS members. We hosted the survey through SurveyMonkey.com, which ended up being an inexpensive and easy way to host this survey. For those of you who participated in the survey, we thank you for taking the time to tell us what you think.

". . . the board did not really understand what NACIS members thought about the journal."

After deciding on the delivery method for the survey, the next big issue was to develop the questions. Between the fall NACIS meeting and the end of 2008, several iterations of the survey questions were circulated among *CP*'s Editorial Board members. The final set of questions is displayed in Table 1. In designing the questions, the overall goal was to find out the NACIS members' opinions about *CP*'s content. We used a combination of fixed-choice questions and open-ended questions that allowed more latitude for each respondent to use his or her own words to express what is appealing about *CP* and what needs to be improved. We will first review the logic behind the various questions asked in the survey and then examine the responses to the questions in some detail.

1. When your copy of CP arrives in the mail, which sections do you read?
2. What kind of changes would you like to see in CP's content? In your response, please consider what sections you would like eliminated and suggest possible new content.
3. To help reduce publication costs, would it be acceptable for CP to be published twice a year instead of its current three times a year schedule?
4. To reduce printing costs and limit paper usage, would you be in favor of receiving only an online version of CP?
5. Would you be willing to pay higher membership dues if CP continues to be published three times a year in print format?
6. Would you ever consider submitting content to CP for publication consideration?
7. If you would not consider submitting content to CP for publication, could you comment on what prevents you from doing so?
8. Have you ever considered submitting to CP, and then elected to submit to another journal instead?
9. Which journal(s) have you opted to submit to instead of CP?
10. Why did you decide to submit to the alternative journal(s) you listed above?
11. Have you ever submitted an article to CP for publication consideration?
12. How would you rate your experience during the CP review process?
13. Please comment on anything else dealing with CP that would help to shape its future and ensure its longevity.
14. What is your profession?
15. How long have you been a NACIS member?
16. Have you ever attended the NACIS conference?
17. How regularly do you attend the NACIS conference?

Table 1. Questions asked in the CP *Survey.*

"Coupled with new delivery mediums (such as blogs and other Web-based forums such as CartoTalk) and other publication outlets (such as Map & Geography Libraries*), we were interested in how relevant the current sections are to NACIS members."*

The purpose of the first question was to find out which sections of the journal are read more often than the others and, more specifically, which sections, if any, are not examined all that frequently. Those that are not examined with great frequency could be targeted for changes or replaced with other more interesting content. Although the nature of the individual sections in *CP* has changed since it first appeared, more recent issues have been consistent in the content offered by the various sections. The second question focused on what the membership would like to see changed in *CP*'s content. We were conscious that there have been changes in the map-making practice since *CP's* inception. Coupled with new delivery mediums (such as blogs and other Web-based forums such as CartoTalk) and other publication outlets (such as *Map & Geography Libraries*), we were interested in how relevant the current sections are to NACIS members. Printing *CP* is a considerable cost to the organization. While printing costs have remained relatively stable over the years, other journals have made their content available over the Web, for a variety of reasons. There are many benefits to a Web-based offering: reduced paper consumption, more timely delivery, easier access for current readership, as well as the potential for broadening the readership of the journal. However, there are also tradeoffs to consider when the board deliberates over making any potential changes to the journal. The third, fourth, and fifth survey questions sought information on the willingness of NACIS members to consider changing the frequency of the journal's publication or to make the move to providing the journal exclusively via the Internet.

We were also aware that *CP* is not the only journal that publishes cartography-related material. Hence, we were curious as to whether or not members consider *CP* as an outlet for their publications. Moreover, if they did not consider *CP,* we wanted to know what kept them from submitting to the journal and why they decided to publish elsewhere. These concerns formed the basis of questions six through ten.

We also wanted to add to our knowledge about the experiences of those individuals who have submitted something to *CP*. The review process should be a beneficial and smooth experience for the article author(s), reviewers, and the editor. Therefore, we wanted to hear about the good and bad of *CP*'s review procedures in order to further improve the editorial process. We designed questions eleven and twelve to provide us with this information.

"The review process should be a beneficial and smooth experience for the article author(s), reviewers, and the editor."

Finally, question thirteen was developed to allow the membership to provide comments on issues that they felt were missed by the previous twelve questions. Questions fourteen through seventeen were created to capture some basic information on the demographics of survey respondents so that we could see if we had responses from a broad cross-section of NACIS members. These demographic variables served an important role in performing some cross-tabulations in the analysis.

SURVEY RESULTS

This section presents the results of the survey. We will begin by presenting some basic demographic information on the respondents. Next, each question will be presented individually along with its results. There were a total of 237 respondents who took part in this survey. This comprises 26 percent of the NACIS present and former members database (n = 901), to whom the survey was sent out. We received responses from a wide range of NACIS members, who work in a number of different types of jobs (Figure 1). Our respondents ranged from long-time NACIS members who have supported the organization since its inception to freshly-minted Nacites (Figure 2). Most of the respondents (73 percent) had attended our annual meeting at least once, but we also received replies from some members who have never or only occasionally attended the conference (Figure 3). Therefore, we believe that the survey provides us with a set of responses that do reflect the diversity of the NACIS membership.

"There were a total of 237 respondents who took part in this survey. This comprises 26 percent of the NACIS present and former members database (n=901)."

Which sections of CP do NACIS members frequent and how could we improve the content that we offer in CP to better meet members' needs and match their interests?

As shown by Figure 4, the Mapping Methods and Techniques section is always read by the highest percentage of survey respondents, while fewer than 30 percent of respondents always read the Letters from the Editor and Book Review sections. Most respondents read the sections that they don't regularly read at least occasionally. When compared to the other self-ranking criteria, few respondents reported rarely or never reading sections. Those sections that were most commonly rarely read included the Letters from the Editor, Book Reviews, and Cartographic Collections.

In reviewing the ninety-four suggestions that respondents made about what they would like to see changed about *CP*, we classified suggestions into general categories of the types of changes that respondents would like to see. Types of suggested changes include: practical tips on how to accomplish a mapping task (15), more maps (12), more information on software capabilities for those thinking about trying a particular platform

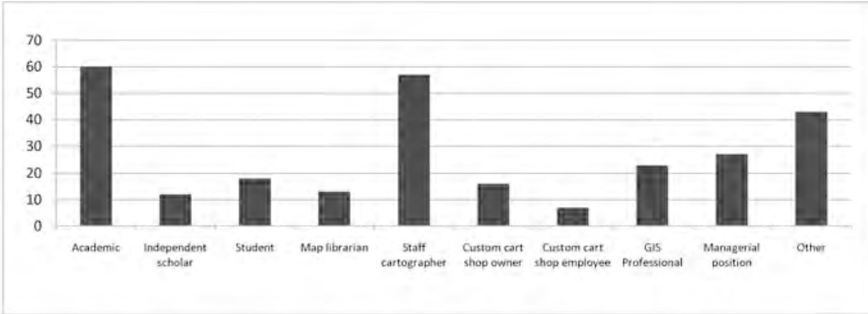

Figure 1. Survey respondent professions. Some respondents indicated more than one profession, so the total number of professions exceeds the number of respondents.

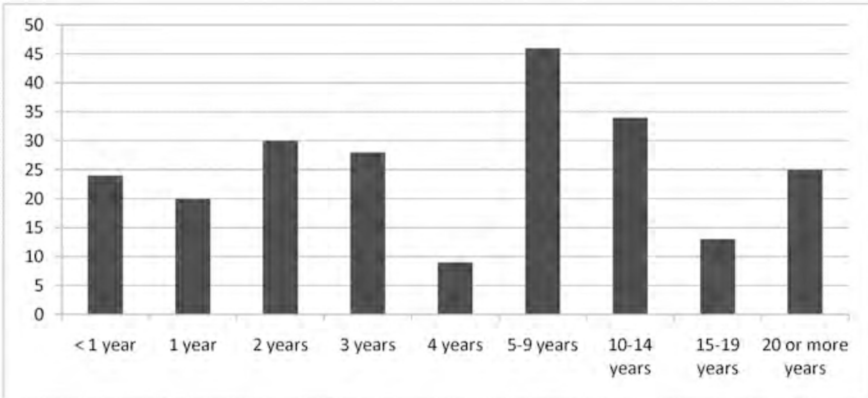

Figure 2. Length of NACIS membership among survey respondents.

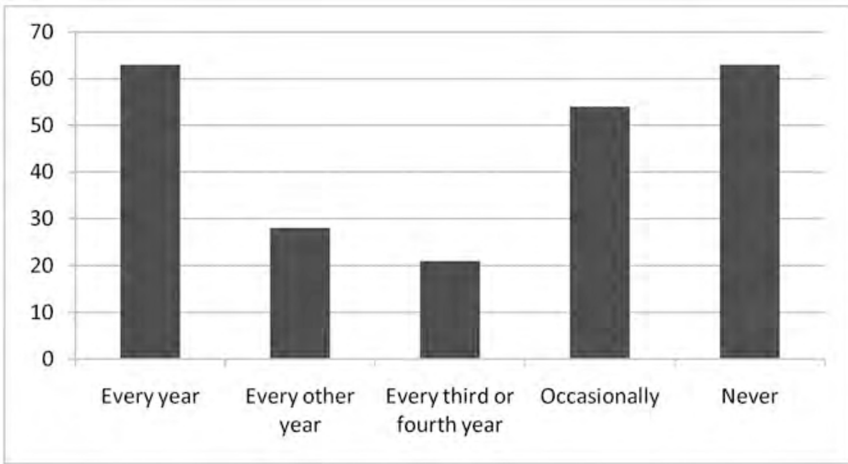

Figure 3. Frequency of NACIS annual meeting attendance by survey respondents.

". . . practical instruction, more maps, and technical aspects were the areas which generated the greatest number of suggestions."

(11), critical-social theory/history of cartography (4), refereed articles (4), map librarianship (3), and teaching cartography (1). It was interesting to note that practical instruction, more maps, and technical aspects were the areas which generated the greatest number of suggestions. "Short, descriptive pieces on how a particular map was made, especially using a creative 'trick' or unusual design technique" and "New approaches with Illustrator, work-a-rounds with ArcGIS, new datasets, etc." echo the sentiments expressed for the practical instructions category.

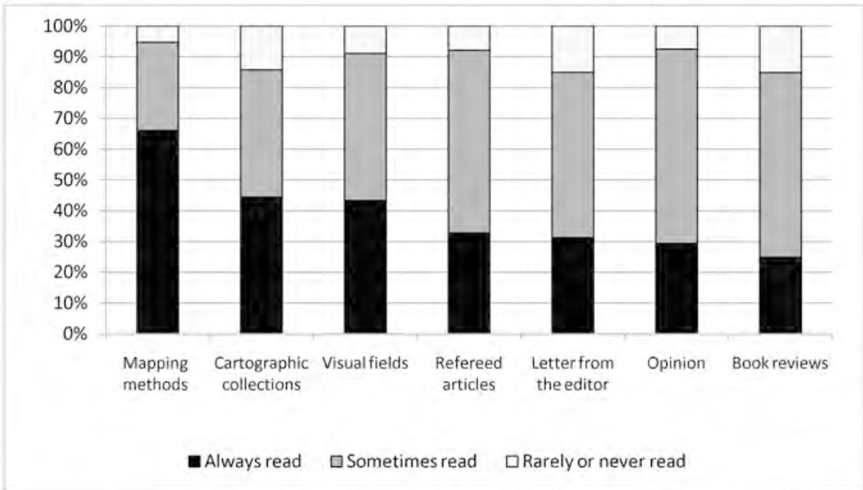

Figure 4. Percent of respondents indicating frequency of reading CP *sections.*

In the technical aspects area, responses generally agreed that the current Mapping Methods and Techniques section was the one they almost always read. But, they would like to see more content that specifically addressed software, tools, and applications and how these are being integrated to make well-designed maps. Since *CP* is all about maps, it was not too surprising to read that NACIS members also wanted to see more maps and discussion about these maps printed in the journal. A typical response in the "more maps" category was the following comment:

> I don't read (or need) articles on skill-building--if I need to learn something, I'll be doing seminars/tutorials--not going to a *CP* article that will be dated, no matter how current when written, within a year or two. What I like best is seeing clever, imaginative maps, then essays on who made this map, how, what value or audience targeted. I get more from seeing what other mapmakers are doing, rather than reading the latest "publish or perish" paper from an academic.

". . . [respondents] would like to see more content that specifically addressed software, tools, and applications and how these are being integrated to make well-designed maps."

An additional idea offered for inclusion was to report on what cartography majors were doing or their projects. There were also a number of responses (33 in total) that indicated that the journal should not change its content.

Publication Frequency and Format

Three-quarters of respondents (75 percent) indicated that they would be in favor of reducing *CP*'s printing frequency to reduce printing costs. Depending upon page count and the number of color pages, each issue of *CP* costs approximately $7,000 to produce and distribute. Printing costs have been creeping upward and are likely to continue to do so. A year's worth of *CP* costs NACIS about $21,000. Reducing the publication frequency to twice a year or making the journal available online would help to reduce printing costs considerably.

"A year's worth of CP *costs NACIS about $21,000."*

In recent years, perhaps as a cost-cutting measure, many journals have given their readership the option to receive their subscriptions entirely online, entirely in print, or both. Opinion was divided on whether or not to publish *CP* exclusively online, with 50 percent of respondents indicating they would be in favor of receiving only an online version, while

50 percent were not in favor. A slightly greater number of respondents (117 vs. 115) indicated they are not in favor of an "online only" option. A significant contingent of NACIS members appears to prefer receiving a printed version. There was no relationship between length of membership in NACIS and whether or not a respondent was in favor of an online-only version of *CP*. Interestingly, however, of the 23 respondents who have been NACIS members for less than a year, only 13 percent were in favor of an online-only version, a much lower percentage than for other lengths of membership. One interpretation of this may be that new members need something tangible from their NACIS membership as they have not yet had a large amount of exposure to the organization and the personal connections and knowledge they develop through interacting with other NACIS members. This may indicate that retaining a print version of *CP* could play an important role in making new members feel like they are a part of the organization.

". . . retaining a print version of CP *could play an important role in making new members feel like they are a part of the organization."*

Two-thirds (66 percent) of respondents would be willing to pay higher membership dues to keep the same *CP* publication frequency. Currently, NACIS regular members pay $42.00 per year in annual dues (students pay only $28.00). Compared to other cartography journals, *CP* dues are very reasonable. This willingness to pay increased dues in order to maintain both the current publication frequency and a printed version of *CP* seems to indicate that members are broadly satisfied with the current frequency and format of *CP*.

Contributing to CP

Almost all survey respondents (87 percent) indicated that they would consider submitting content to *CP* for publication consideration. More academics and students than cartography and GIS professionals or map librarians indicated that they would consider submitting to *CP* (100 percent vs. ~83 percent). This is perhaps not surprising given the imperative for academics and students to publish their work, but it is encouraging to see that even members without a professional requirement to publish might consider submitting something to *CP*.

The few respondents who would not consider submitting to CP answered a follow-up question. In reviewing the responses to the follow-up question, several barriers appear to be preventing individuals from contributing to *CP*. Eleven respondents indicated that they did not have "enough experience" to contribute to *CP*. Specifically, what constituted "experience" took on a number of qualifiers. In some cases, experience included the following: "I do no research that could be published," "I don't feel like I have enough cartographic knowledge to write an article," "I only have a Master's, not a Doctorate. My assumption is that I don't have the credentials," and "I don't believe I have anything to contribute that would qualify for publication." Four people indicated they simply "don't do research." Another four respondents indicated that they did not have "enough time" or were "too busy" to contribute to the journal while another four indicated that they "are by no means a good writer." My experience as Editor of *CP tells me that* good writing has never been a qualifier for submitting something for publication consideration.

". . . (87 percent) indicated that they would consider submitting content to CP *for publication consideration."*

Of those respondents who have considered submitting to CP, 18 percent of respondents decided upon another outlet. A somewhat larger percentage of academics and map librarians submitted their work elsewhere than did professional cartographers (32 percent and 38 percent versus 12 percent). By far, *Cartography and Geographic Information Science* (*CaGIS*) and *Cartographica* were the two journals that were most commonly targeted by members who considered *CP* but submitted elsewhere. *CaGIS* was mentioned fourteen times while *Cartographica* was listed twelve times. Journals listed three or fewer times included *Journal of Geography and Map Libraries*, *Annals of the Association of American Geographers*, *Geographical Review, The Professional Geographer*, *The Cartographic Journal*, *Transactions in GIS*, *The International Journal of GIScience, Computers & Geosciences, Coordinates, Bulletin of the Society of Cartographers*, *Imprint*, and *MapReport*. There were also a handful of journals that were mentioned only once. Additionally, one respondent indicated that s/he only published in "higher ranked journals" and s/he did not feel *CP* warranted a higher ranking.

Those respondents who chose to submit their work elsewhere were driven by a number of considerations. The most prevalent reason that their work was submitted elsewhere related to *CP*'s reputation (or lack thereof). Some respondents were of the view that, compared to other cartographically-themed journals, *CP* has a weaker reputation and that those seeking tenure or other academic promotions would necessarily choose to publish elsewhere. Responses such as "higher profile journals with wider readerships," "prestige of the journal," and "better academic reputation, larger readership" were indicative of how some individuals view *CP* and its order within the ranks of academic cartography journals. Other responses mentioned that publishing exclusively in one journal was not appropriate. For instance, one response indicated that they had recently "published in *CP* and need to establish a diverse publication portfolio for promotion and tenure."

". . . "higher profile journals with wider readerships," "prestige of the journal," and "better academic reputation, larger readership" were indicative of how some individuals view CP*."*

Another category of responses focused on the "poor fit" between the respondent's specific research topic and the journal. For instance, one respondent indicated that other journals have a "more international perspective; larger readership." Another respondent said that they thought that other journals had "reviewers [that] would be more knowledgeable." Still another individual noted that "*CP* had little history in the topic of my choice." A surprising response, given the history of NACIS and its founding members, came from a respondent who stated that s/he didn't think "*CP* would be interested in an article about a specific aspect of map librarianship." However, *CP* has an entire section devoted to Map Librarianship.

A handful of responses indicated that their decision was based on a previous problem with the review process or that their decision not to publish in *CP* was due to the journal's not being available online.

Experience with submitting to CP

Figure 5 shows the number of respondents who have ever submitted to *CP*. Approximately one-third of respondents (29 percent) have submitted something for publication consideration. Competition for content is tough in the print world, and academic cartography journals are no exception. *CP* continually struggles with finding sufficient content, and it is apparent that a small number of respondents supply the bulk of *CP's* content. For reasons we will explore later, a majority of *CP*'s readership has not contributed to the journal for a variety of reasons.

*"*CP *continually struggles with finding sufficient content, and it is apparent that a small number of respondents supply the bulk of* CP*'s content."*

Those who have submitted to CP have generally had positive experiences with the review process (85 percent), while a smaller number of respondents had neutral views about their experience(s) with CP reviewing. Looking over the individual responses to this question, it appears that the most common response was that the submitter had no problems with the review process (18). However, there were a small number of complaints about the review process. Some of these complaints included issues authors had with the overly negative comments made by some of

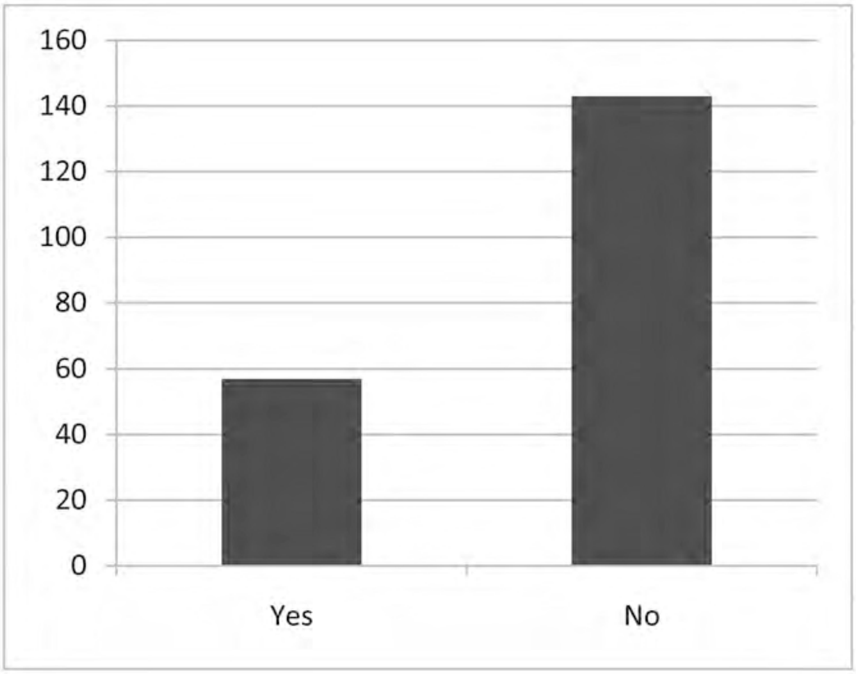

Figure 5. Number of respondents who have ever submitted to CP.

the reviewers. For instance, one respondent offered their experience with overly harsh or negative reviewer comments: "One of my reviewers was rather negative…their comments, though somewhat helpful, were difficult to swallow and I could not consider them as constructive." Other complaints include the view held by three respondents that *CP* includes only "theoretical-based" articles. One such respondent's opinion was that s/he felt the reviewers were "hardcore academic reviewers who insist that EVERY peer-reviewed article in *CP* have a theoretical component--diversity be damned. My articles do not fall in this category." Another individual offered their experience in that the "Editor liked the piece but it was neither "technical" enough nor 'scientific' enough for the readers."

". . . put CP *online."*

On a different theme, three individuals felt the review process took too long. One of these individuals commented on their experience: "[I] t took over six months to get the reviews back and then took almost two years for it to come out in print." Aside from these issues, one individual suggested that "when circumstances warrant, the anonymity of the review process be lifted so that the reviewers and author(s) be able to discuss the particulars of the manuscript, its merits, and shortcomings."

Any other suggestions

Our final question generated by far the greatest number and range of responses. While it is difficult to parse out every idea offered in these responses (and there were quite a few–101 to be exact), several general themes do appear. One of the most frequently suggested improvements is to put *CP* online. There were, however, many different ideas on what constitutes "online" for different respondents. In the simplest case, putting *CP* online meant that the entire journal would be fully accessible/searchable to anyone in a convenient format (such as PDF). Some individuals voiced an opinion that a newly designed *CP* online should completely replace the print version, arguing that the online version would cut printing costs and be more convenient and accessible to readers. A smaller number of individuals voiced their preference for keeping a print version available. Putting *CP* online also conjured up ideas of creating a *CP*-like blog, social network page, or an open source environment. Yet another avenue for exploration was to get *CP* into more visible electronic databases, which would encourage a wider and larger readership.

Another general category of suggestions related to expanding or changing *CP*'s content. Generally, academics were pleased with the diversity of topics covered in CP, while higher numbers of map librarians and professional cartographers suggested that the journal should include more content that was directly relevant to their work. Some of the more insightful offerings are reproduced here:

> "NACIS membership includes not only cartographers but archivists, librarians, historians, educators, and so on. If *CP* included content that reflected its membership that would be helpful"

> "Expansion of content related to maps that represents the map community and subscribers"

> "The common thread among NACIS members is the appreciation of maps--how they function, their influence on society, as art, their history, etc.   Keep the focus on the map itself."

> "Given a choice of publishing something like "Lesser known Azimuthal Projections of the 20st Century" (with 47 footnotes, many distorted single-line projection silhouette maps) or "Cartography in Hiroshige's 1850's 'Road to Tokaido' woodblocks" (0 footnotes, lots of pretty woodblock illustrations) publish the latter."

> "Keep things practical, yet imaginative and artistic!"

> "Less academic, more practical. It has been the formula for success for the conference."

"Keep the focus on the map itself."

Another theme to emerge from the numerous comments was that the overall design of the journal should change. Some argued that the current design includes too much white space and a new design could make better use of the page space. Others questioned the thickness/type of paper used for producing the journal, its excessively large type size, and inclusion of margin quotes as ways to either reduce printing costs or change the overall appearance of the journal. Other suggestions asked if the color figures could be printed within each article rather than at the end of the issue.

There were a minority of individuals (two) who voiced a need to increase the frequency of *CP*'s publication. In fact, one of these individuals thought that they would "love to see a *CP* in my mailbox (or inbox) every other month." Some of the other less frequently recorded suggestions included paying higher dues to keep *CP* in publication three times a year, considering merging the various cartography journals into a single journal, and including advertising in the journal.

A number of individuals (nineteen) commented that they were pleased with the current state of *CP* and suggested that the journal should not change. One respondent enjoyed the "variety of articles that I can't read in any other publication regarding cartography" while another respondent said that *CP* is "a great publication representing a focused community of

*"*CP *is "a great publication representing a focused community of professionals."*

professionals . . . small enough to feel intimate while representing some of the best in the field."

DISCUSSION OF SURVEY RESULTS

There is considerable food for thought that has been offered by NACIS members who responded to the editorial board's survey. The problem is to distill these suggestions into a workable plan that will meet the membership's desires for *CP*. It will be impossible to satisfy everyone and implement all of the suggestions. So, the problem of how to best steer *CP* on a navigable course though the waters of *CP*'s readership remains. Here, we discuss a few of the main issues that were raised and some possible ways of addressing these issues.

". . . how to best steer CP *on a navigable course through the waters of* CP*'s readership remains."*

Put *CP* Online

One of the more telling suggestions is to place *CP* online in some fashion. Given the digital age in which we now live, this is certainly a worthy criticism. As pointed out earlier, however, online means different things depending upon whom you ask. For instance, offering *CP* via the Web (e.g., in PDF format) could help to reduce printing costs, increase the frequency of issue offerings, reduce impacts on the environment, and allow individuals (both members and non-members) to have access to the wealth of information contained in the back issues. Placing *CP* online can also improve the journal's reputation and availability to a larger audience that may not be aware of what the journal offers. Granted, *CP*'s readership is rather small. This is not necessarily a bad thing, but since the NACIS members seem to like the idea of *CP* it would seem logical that others outside of the immediate NACIS community would also benefit from reading the journal. There is also the idea that moving the journal to an online environment may help draw in those map makers not in academia who may feel a bit marginalized by the current content and focus of the journal. We can report some positive steps that have already been taken to help address this general "online" direction that *CP* should take.

First, we are happy to say that back issues of *CP* are now freely available online in PDF format for downloading and viewing. Note though, that the NACIS Board did impose a two-year embargo on the journal's availability. Membership in NACIS does have its privileges. Placing back issues of *CP* online will help individuals who were frustrated that they don't have access to "such-and-such" an electronic database or a university library that subscribes to the journal. What's more, you don't have to be a member of NACIS to download any of *CP*'s back issues. However, it is hoped that non-members who visit the site will become interested enough in the more recent issues of *CP* and the organization to join.

". . . back issues of CP *are now freely available online in PDF format for downloading and viewing."*

Second, there is also a strong possibility that NACIS will soon manage CartoTalk. This hugely successful and popular Web environment has been an important component for the cartographic profession. Involving CartoTalk with NACIS can only help increase the awareness of *CP* beyond its current, relatively small readership. In more actively promoting *CP* within the realm of CartoTalk, it is hoped that a whole new audience that includes possible suppliers of *CP* content will emerge.

Finally, at the fall NACIS conference, a special all-digital version of *CP* will be announced. This special issue will serve as a model of what may become a regular, albeit separate, component of *CP*. This special issue will have a unique focus in that all of the content will highlight technical aspects of map making. So, there are no "research" oriented articles or theoretical pieces on obscure mapping practices of the Prussian Army. This special content issue may become an instant hit with *CP*'s readership.

Change *CP*'s Content

Another seemingly popular current of discussion was *CP*'s content. If you look back at the previous issues of *CP*, you will note that, while its primary focus has been on the peer-reviewed articles, its content has changed somewhat over the years. As with any journal, the ebb and flow of the membership's interests should be addressed and incorporated where appropriate. However, we find it difficult to reconcile the vast array of suggested changes to *CP*'s content that were expressed. On the one hand, there seemed to be a call for more research-oriented articles while at the same time fewer research articles were desired. Similarly, sentiment was expressed for a move away from empirical or theoretical articles in favor of more "practical" cartography articles. Of course, practical cartography has as many directions as placing the journal online. If you examine the first question from the survey as to what section of the journal is read most often, the Mapping Methods and Techniques is a clear winner, with the Cartographic Collections and Visual Fields coming in a distant second. The remaining sections are seemingly not as frequently read by NACIS members.

". . . the ebb and flow of the membership's interests should be addressed and incorporated where appropriate."

On the one hand, if the number of peer-reviewed articles is decreased in favor of expanding the other sections, *CP* would likely lose what little status it has in the academic community (and academics do look toward *CP* as a publication outlet for tenure and promotion). The number of peer-reviewed articles could remain constant, but an increase the number of pieces in the other sections is a possible consideration. However, this move would necessarily increase the page count and thus increase printing costs. There seems to be a consensus that membership would be willing to pay higher dues to help offset higher printing costs, so this may be a reasonable direction in which to take the publication. Of course, if the journal moves to being exclusively online (a move not unanimously supported by *CP*'s readership), then printing costs would be a moot point.

Speaking from the Editor's chair, I can report that submissions to the journal are very slim. At the time of writing this article, the number of peer-reviewed submissions is three (3). Yes, you read correctly, three. The most difficult section to pull content for is the Mapping Methods and Techniques. There are plausible explanations for this problem. As reported by the survey responses, there are other factors complicating this issue as well. For instance, those in professional cartographic circles often simply don't have the time to craft an article for this section, perceive themselves as not being particularly adept at writing, or do not necessarily want to give away their trade secrets. We would like to encourage those of you who believe that you don't do research to think about your work from a different perspective. Do you ever have a difficult technical or design problem to solve? If you have come up with a solution, then you likely have done some research, and it is likely that your solution would make an excellent contribution to the Mapping Methods and Techniques section. If you do not feel confident about your writing skills or don't have the time to complete an entire submission on your own, why not team up with another NACIS member to work on your ideas together? A fantastic place to start such a partnership might be at the annual NACIS conference!

"At the time of writing this article, the number of peer-reviewed submissions is three (3). Yes, you read correctly, three."

Another possible explanation for our difficulty in finding Mapping Methods and Techniques submissions is that material for this section is comprised of timely advice for software products. As we all know, software goes through changes at an accelerated pace, which means that timeliness in getting the technique to those in need is of the utmost importance. In the current queue, an article submitted for the Mapping Methods and Techniques section normally takes six months or longer to go to print. If this special all-digital issue of *CP* is successful and can maintain some kind of longevity, perhaps this environment would be a better place for the technique-oriented pieces than the print journal.

"What would be a better way to showcase the talents of students for all to see than a special section in the journal?"

If the Mapping Methods and Techniques section moves from the print issue to the all digital version, what would replace this void? The survey seemed to offer some insightful ideas here. One suggestion that seemed plausible was to include a section that focused on cartography students. This could include a recent project/map upon which they worked, an explanation of a research project, or perhaps a summation of an interesting internship experience in which a student was employed. Currently, there is nothing unique that *CP* offers to students. What would be a better way to showcase the talents of students for all to see than a special section in the journal? Another suggested section was to showcase or highlight various mapping companies and some of the employees who work there. This would be an interesting way for everyone in mapping profession to learn a bit more about one another and what makes their approach to mapping special.

CONCLUSIONS

In January 2009 an email was sent out to the NACIS membership asking for their participation in a survey on *CP*. The survey's purpose was to determine people's opinions about *CP* and what its future may hold. While the opinions expressed varied considerably, the main thrust of the survey results suggests that *CP* needs to change. Among the types of 'change' reported was a strong opinion that *CP* needs to have an online presence. As you may be aware, the print industry is reeling under the pressure from the web and other digital devices that offer access and delivery of information. In some cases, journals have offered a mixture of print and online offerings to its readership. In other cases, journals have done away with the print side completely and delivered its content exclusively online. In some respects, the issue of web delivery and accessibility has been addressed. A digital archive of older *CP* issues is now freely available to anyone simply by visiting the NACIS website. However, there is a two-year embargo on posting current issues. Obviously, more work on merging the print version of *CP* with the digital services that the web offers has yet to occur. Another strong sentiment expressed by the survey respondents was to change the contents of *CP*. Some wanted more topics that focused on the technical aspects or "hands-on" of using software to make maps. Others wanted to simply see more maps in the journal. Addressing these issues will take some time and involve discussion with the NACIS membership to decide how best to implement these and other changes voiced in the survey results.

Aside from these issues, one overriding problem remains: Submissions. As of this writing, *CP* has received three (3) articles since the start of 2009. At this current pace, *CP*'s publication schedule is going to lag and the vitality of the journal will surely falter. The readership survey did address the issue of submissions to *CP* and the responses did prove to be a mixed bag of sorts. On the one hand, the survey reported that a high percentage of respondents would consider submitting something to *CP* for publication consideration. However, only one-third of the respondents have in fact submitted something to *CP* for publication consideration. It is clear that the bulk of submissions to the journal do not necessarily come from the NACIS community. The question remains what is needed to increase submissions? Will changing *CP*'s content to reflect the interests of the journal's readership result in a renewed submission vigor? If *CP* can better integrate with the web, then will this ensure the journal's vitality? It is likely that none of these singular approaches will be the cure-all. Rather, it is more probable that some combination of these solutions and other possibilities that will see to restoring the long-term health of the journal.

NOTES

[1]The number in parentheses indicates the number of responses received in each category.

Reviews

Cartographic Cinema
by Tom Conley
Minneapolis: University of Minnesota Press, 2007.
viii, 264 pp., 40 figures, endnotes, bibliography, filmography, index.
$26.50 Softbound
ISBN 0-8166-4357-1

Reviewed by: Daniel G. Cole
Smithsonian Institution, Washington, DC

Given my own career in cartography, along with my son's early career in theater and film, I could not resist offering to review this groundbreaking work concerning the intersection of these two visual media. How these two mediums of communication relate to one another is the focus of the book and this review.

Throughout the book, Conley quotes heavily from--and builds on the works of--two French film theoreticians, André Bazin and Gilles Deleuze. At this point, I must recommend reading the endnotes with the text; these twenty-four pages of notes are crucial to understanding the author's point of view. Because the endnotes are a vital part of his discourse, this book is not quickly read, and should be digested slowly.

In many books, a reader can skip the introductory chapter--not here. Conley's Introduction is critical to understanding his movie reviews in the ten chapters that follow, a collection of essays covering the history of twentieth century cinema, primarily focusing on films from France and the United States. The author begins by positing that maps appear in most movies. He further argues that "A film can be understood in a broad sense to be a 'map' that plots and colonizes the imagination of the public . . . ." (1). As a point of pride for cartographers, he also states that "The force and beauty of cinema are enhanced when we think of it in light of cartography"(5). Conley notes that the first shots of a movie establish a real or artificial geography for the viewer on which to speculate. He presents two hypotheses: "[A] map in a film is an element at once foreign to the film but also, paradoxically, as the same essence as film;"(2) and "[R]ivaling with the proposition that rare are the films that fail to contain maps, is that the occurrence of a map in a film is unique to its own context" (5).

A number of related points are made in the course of the introduction, including: 1) maps in a film often serve as archival diagrams regarding the history and strategy of the film; 2) the film viewer, in essence, occupies an 'unmoored, self-detached position' as the movie progresses; thus, 3) maps provide a trajectory of travel across the cinematic landscape; 4) accurate maps can help the viewer relate to the filmed locality; whereas, 5) inaccurate or inauthentic maps might confuse the viewer in time and place; 6) one's cognitive map of a filmed location is compared with that of the film; 7) many films promote self-mapping where the viewer becomes transported into another time and space; 8) maps and the films in which they reside provide a type of 'mobile topography'; 9) a film is an animated map providing a geography in context; 10) maps that appear in films are often coded or controlling images of facts; and finally, 11) the great auteurs [authors] of films make maps of their movies (pp. 14-21).

Chapter 1 deals with the film *Paris qui dort* [literally, *Paris that Sleeps*, but the English version title is *The Crazy Ray*] (1923), a silent science fiction movie in which a mad doctor freezes life. The lone person to escape the ray is the night watchman on the Eiffel Tower, who wakes up one morning to discover all life has stopped. From the top of the tower, he has a "bird's eye" or panoramic view of the city. This film also has an anthropomorphic globe, in a lower corner of the screen, that grimaces or smiles depending on the content of the printed remark. Even though the film is limited in scope to Paris, the inter-titles with the little globe globalize the actions.

In Chapter 2, the author examines four films of Jean Renoir from the 1930s. Conley states that maps appear at critical junctions in Renoir's films, begging viewers to see them as "human topographies"(40). In *Boudu suavé des eaux* [*Boudu Saved from Drowning*] (1932), eight baroque folio maps can be seen in a bookstore window early in the movie. Here, "maps inspire questions concerning where the personages are and how the viewer relates to their own perception of their place in space" (44). Next, Conley reviews *Le Crime de Monsieur Lange* (1935), where the map takes on a life of its own, as a "character" in the movie, appearing in three different localities. In *La Grande Illusion* (1937), a prisoner of war is seen piecing together map fragments sent in chocolate bar wrappers. As he constructs his incomplete map, it can be compared to other maps used by the military. Lastly, with *La Règle du jeu* [*The Rules of the Game*] (1939), a pair of conspicuous globes is seen numerous times at the end of a balustrade to a chateau, appearing both as globes and as cannonballs, encompassing both empire and military power.

Chapter 3 covers Rossellini's film, *Roma, città aperta* [*Rome, Open City*] (1945), a movie that reflects on maps and a "theater of cruelty and torture" in World War II. Conley's "guiding hypothesis of this chapter is that in the film Rossellini taps into the tradition of *theatrum mundi*, a world-theater conceived as an atlas of maps with which its owners can assuage their broadest desires for travel and displacement" (66). Maps in this movie are used to decorate different rooms, and, especially in the map room (located next to the Gestapo torture room), maps are used by the actors and viewers to travel without leaving the room.

The fourth chapter covers four American films, beginning with *High Sierra* (1941), in which Humphrey Bogart plays an escaped criminal on a desperate journey in a "rush to death." The movie has a montage sequence that in part features a map; a hand is seen pressing tacks as the pursuit of the criminal narrows. An iris dissolve reinforces the image of the tightening search. Basically, "the film uses maps to situate and enclose the tragic hero"(88). *Desperate Journey* (1942) starts with the first of a number of maps of northern Europe which covers the territory where Errol Flynn and Ronald Reagan conduct an aerial bombing mission over Nazi Germany, crash, get captured, escape in a cross-country car chase, and finally steal an airplane to go home.

Casablanca (1942) opens with the three main actors' names (Humphrey Bogart, Ingrid Bergman, and Paul Henreid) superimposed over a map of Africa. This scene is followed by a globe that re-orients the viewer by starting over the north Pacific, which then rotates and zooms to India, the Middle East, eastern Africa, and finally to Paris. At this point in the narrative, lines of fleeing refugee trails are traced on a map, ghosted over stock photos of the refugees, to Troyes and Marseille, across the Mediterranean to Morocco, and stopping at Casablanca. Interestingly, no name accompanies the dot for Casablanca, but when the map reappears at the end of the movie, this city's name appears on the map. In *Indiana Jones and the Raiders of the Lost Ark* (1982), another desperate journey's itinerary is mapped by a red line drawn over a Mercator projection and under the image of a Pan American overseas cruiser.

Chapter 5 discusses *Les Mistons* [*The Rascals*] (1957) and how the film presents cartographic allegories within a figurative juvenile geography. "From its very first shots *Les Mistons* betrays a new sense of cartography through the marriage of mapping to cinema. A geographical space is plotted and espoused in the narrative in which children seem to be orphans of the world they inhabit" (122). The sixth chapter concerns *Les Amants* [*The Lovers*] (1958), a movie that deals in part with the interplay of an estate map, a Michelin road map, and an allegorical map, *Carte du Pays de Tendre* [*Map of the Country of Love*]. In this film, two lovers plan their travels, in which a desperate journey becomes tender travel. Conley declares in Chapter 7 that "Few cities are riddled with maps as much as Paris in Truffaut's first full-length feature," (142) *Les Quatre cents coups* [*The 400 Blows*] (1959). Early on, a maze of maps is presented along a classroom's four walls, portraying the interaction between maps, French history, the teacher, the children, and a disciplined child. Late in the movie, cartographic versus physical memory is addressed by one of the characters (now grown) while reminiscing (233).

In Chapter 8, the author expounds upon how the maps in *Thelma and Louise* (1991), can "have an engaging and unsettling presence" (156). This movie portrays another desperate journey, this time for two women, who, after killing a rapist, unsuccessfully consult a road map to plot their escape. Later, in a motel room, three decorative baroque maps obviously fail to alleviate the women's feeling of being lost. Meanwhile, a tractor trailer, labeled "Zip," drives by. "In an alert but unpublished sequence, T. Jefferson Kline notes that 'Zip' is a 'sort of message without a code.' Systems of surveillance and advertising use 'zip codes' to locate where and who we are. At this moment, when they are 'zipped,' the two ladies are totally lost" (234).

Chapter 9 presents *La Haine* [*The Hate*] (1995), which covers the 1968 student riots and their aftermath. Three maps appear in this film: 1) the Apollo image of the earth as seen from the moon (in the opening credits and later in the city and suburbs on advertisements); 2) "a meteorological map of France under which the children place themselves for a moment indicates that the film is an allegory and its meaning moves from *police* to *polis* and from *polis* to *cosmos*" (190), and 3) somewhat less noticeable, a type of world projection onto the black and white splotches of a cow about which one of the characters "seems to imagine a world-map . . . that his fantasies bring into the courtyard of the housing project" (190).

For the last film that Conley reviews, *Gladiator* (2000), the emperor Marcus Aurelius asks Maximus to "look at this map" (195). For the viewer, this quick look at a map of Italia (by Ptolemy?) only provides the northern portion of the empire, perhaps indicating that Romans may have been too ambitious in expanding the empire northward. Later in the movie, the emperor Commodus looks at a 3D model of a coliseum with toy gladiators, which transforms through special effects into a finished stadium. At this point, Conley gets carried away with comparisons of the gladiator games to the modern NFL by emphasizing that "*Gladiator* became a mobile map that moved toward contemporary genres of entertainment and an array of films past and present"(206).

Within his concluding chapter, the author makes these salient points: "[T]he maps we discern in a movie often heighten our awareness about perception and subjectivity" (207), and "a map in a movie can unsettle or displace the inferred contracts tendered at the beginning of every film about the conditions of viewing that follow" (208). But "When a cartographic shape–be it a projection, a globe, an icon of the world, an atlas, a diagram, a bird's-eye view of the landscape, a city-view–is taken as a point of departure, it becomes a model, a patron, or even a road map from which transverse readings can be plotted" (208) and "[C] artography and cinema share in the design of what one critic long ago (Jameson 1982) called 'strategies of containment'" (212).

This book was written more for film historians than cartographers; indeed, it reads like it belongs in a film history classroom. Unfortunately, only forty figures appear in the text for the sixteen films discussed (plus the numerous other films referenced). Given the graphic nature of both cartography and cinema, Conley should have provided more figures to help the reader better visualize his points. While a DVD insert with film clips would provide much appreciated context, I doubt that copyright restrictions would allow such a feature. Regardless of these criticisms, this reviewer will likely never watch movies in quite the same way again.

Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship
Edited by Anne Kelly Knowles, with a digital supplement edited by Amy Hillier, and a foreward by Richard White.
Redlands, California: ESRI Press, 2008.
313 pp., 85 figures, endnotes, bibliography, index, author biographies, CD insert.
$49.95. Softbound
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Reviewed by: Daniel G. Cole
Smithsonian Institution, Washington, DC

This book springs from both a conference at the Newberry Library in 2004, "History and Geography: Assessing the Role of Geographic Information in Historical Scholarship," and as a sequel of sorts to Knowles' earlier edited work, *Past Time, Past Place: GIS for History* (2002), to which it serves as a compendium of projects now completed. More than half of this book's chapters range in topic across time and space, while the others provide theoretical and methodological discussions usable for future research. In total, thirteen authors from history, geography and planning departments across academia present a foreward, ten chapters, and a conclusion to address how maps, spatial data, and GIS are changing historical scholarship.

Knowles begins the introductory chapter by identifying the differences between geographers and historians and notes some reasons why historians have generally been reluctant to use GIS. She posits that historical GIS (HGIS) scholarship combines historical geography and spatial and digital history with databases that record both locations and time, thus enabling maps (including animations) to illustrate changes over time. She uses examples to show that HGIS has been focused on the themes of the history of land use and spatial economy, reconstructing past landscapes and built environments, and infrastructure projects to facilitate the use of HGIS research. Lastly, Knowles helpfully addresses the conceptual and technical challenges facing historians and geographers who plan to use GIS in their research. Particularly, she discusses the paucity of colleagues doing similar work, the ability to recognize geographic information embedded in historical sources, the variable of accuracy in mapping over time, and the lack of standards in documentation.

In Chapter 2, Peter Bol describes the use of GIS for investigating the history of China in a study based at Harvard and Fudan universities. The China Historical GIS (CHGIS) is an ambitious project covering more than 2100 years and ultimately consisting of three elements: "a continuous time series of the administrative hierarchy from the capital down to the county"; "major nonadministrative settlements, particularly market towns that proliferated during the last millennium"; and "historical coastlines, rivers, lakes, and canals" (28). The administrative structure has been modeled as points, for example, capital–county seat–village, with shifting lines and areas of control against the landscape. Indeed, as Bol notes, "For much of the last millennium, demarcating boundaries was the exception rather than the rule" (42). Nonetheless, the CHGIS maximizes the point coverage of settlements as much as possible so that Thiessen polygons can be used to approximate the county boundaries over time. Supplementing that data are compilations of local gazetteers, market networks, lineal villages, and religious networks. In all, CHGIS aims to "take into account such historical shifts in sources and spatial conceptions" (54).

The third chapter, "Teaching with GIS," is split into two parts: "The Value of GIS for Liberal Arts Education" by Robert Churchill and "A Guide to Teaching Historical GIS" by Amy Hillier. In Part I, using several pertinent examples, Churchill discusses how GIS adds value to education. "First, GIS can teach valuable analytical and problem-solving strategies that transcend disciplinary boundaries. Second, GIS emphasizes visualization and underscores the indispensable value of the visual by using maps to communicate results.

Third, GIS engages a variety of important and timely social, economic, and political issues. Finally, GIS can provide a pedagogy that at once serves and cuts across traditional disciplines" (63). In Part II, Hillier uses historical data from Philadelphia to show how GIS was used in a course on urban history. Her students' examples range from W.E.B. Du Bois's map of social class in 1896 to maps of ethnicity, population, commerce, crime, transportation planning, and mortgage practices for the city. Historically mapped data of these types reflect the values and biases of the institutions and people mapping and being mapped.

Chapter 4, by Geoff Cunfer, analyzes the history of the Dust Bowl from the late nineteenth to the mid-twentieth century. His research challenges two assumptions: that dust storms happened where most of the land was plowed and that storms only happened after the massive plow-up of the 1920s. He notes that in the past, case studies were made of individual farms, locations and counties, and he specifically describes one study from the 1970s that evaluates only two counties in Oklahoma and Kansas during the 1920s-30s. More recently, GIS technology has allowed the study of the entire central and southern Plains region of the U.S.; in Cunfer's case,208 counties across portions of five states and from the latter half of the 1800s forward. The author provides five animated maps illustrating average annual rainfall and percentage of total county area devoted to cropland plotted against numbers of dust storms. His results show that while plowing up the Plains did contribute to dust storms, this action by farmers could not be the only factor since many dust storms occurred upwind of plowing. A greater coincidence can be seen on his maps of drought zones overlain by dust storm regions. Cunfer also extends his analysis back into the 1800s by extracting data from local newspapers in the region, thus demonstrating a non-standard method of data gathering for GIS databases.

Ian Gregory, also a co-author with Paul Ell of a recent HGIS text (*Historical GIS: Technologies Methodologies and Scholarship*, Cambridge University Press, 2007), gives the reader a provocative title for Chapter 5: "A Map is Just a Bad Graph: Why Spatial Statistics are Important in Historical GIS." He starts off by bemoaning the typical choropleth map produced by many GIS users. Instead, he advocates going beyond the alleged limitations of thematic maps and making use of spatial statistics in HGIS. I use the word "alleged" since, after all, any good cartographer or GIS specialist should already be aware of using quantitative methods in their analyses. In balance, it must be said, he also discusses the limitations of spatial statistics alone, particularly noting the use of local versus global (or whole-map) statistics to avoid results with spurious spatial correlations. Regardless, he points out how most GIS programs only provide a subset of possible spatial statistical techniques. Gregory then provides examples of three spatial analytical methods used in the study of the Irish potato famine and its demographic consequences from 1841 to 1881 and of infant mortality in Victorian and Edwardian England and Wales. Here, he successfully aims "to show how spatial statistics statistical provide new insights that otherwise have been concealed by the complexity of the data" (129). He finishes by warning that while spatial statistics "is an important and underused tool for historical GIS . . . the greatest challenge to the historian is not performing these techniques but interpreting the patterns that emerge from the data" (146).

The sixth chapter, by Brian Donahue, gives an overview of GIS for environmental mapping of agricultural husbandry in colonial Concord, Massachusetts. He studied various land records ranging from the original land grant in 1635 to the end of the colonial period. His initial analysis makes use of surficial geology, hydrology, and a derived layer of circa-1600 native landscapes. Donahue follows with a map of the parcels of Concord's "First Division," where fifty families made use of the land through divided holdings for houses, farming, and pasture, as well as parcels held in common. He then focuses on the divided, and often widely dispersed, holdings of individual landholders and their descendants. Parcels were typically irregular and described by metes and bounds; the author mapped these by land ownership two-dimensionally and added the third dimension of time. Obviously, his research involved a considerable amount of work interpreting the colonial records and translating them into a GIS database. He concludes by noting that "the bulk of land protection and stewardship in New England is being done by local conservation groups" and that "GIS mapping can serve as a useful tool to guide and inspire grassroots conservation efforts" (175).

Michael Goodchild delivers the seventh chapter on the future potential of temporal GIS. In his text, he provides a historical background to GIS and spatial databases followed by theoretical and methodological discussions on the conceptual design and workings of an HGIS. Tracking data to illustrate lifelines, migrations, explorations, and general tracks and flows can be stored and handled in an object-oriented database for historical analysis, while changing boundaries over time are handled in a longitudinal database in a GIS. Goodchild gives an excellent overall introduction to HGIS databases, and in my opinion his manuscript should have been placed toward the front of the book.

Chapter 8, by Richard Talbot and Tom Elliott, presents a project from the Ancient World Mapping Center, specifically, the creation of a GIS database from the *Peutinger Map of the Roman World.* This map is believed to be a copy of Roman work from AD 300 and survives in eleven sections, each about 33 cm high by 62 cm wide. A series of scans preserves the map in digital form from which route networks, point locations, and physical features were extracted and built into the GIS. Warping this map, however, was not found to be a reasonable task given that the "scale, aspect, ratio, and even the cardinality of the compass points shift from one part of the map to the next as the design struggles to accommodate the competing pressures imposed by its extreme shape" (206). Instead, distance and point data were transferred to the GIS while matching features to the digital version of the *Barrington Atlas of the Greek and Roman World* (Princeton University Press, 2000). The authors tested the assumption that the original cartographer set distances on the map to local usage (Roman miles, Gallic leagues, etc.), but the use of these distance measures by the mapmaker(s) was far from consistent. Nonetheless, the authors found that the fixing of known sites and routes helped fill in missing places and find locations for previously unknown sites. They consider this effort to be only the first stage in the larger work of mapping the Roman and Greek worlds.

The ninth chapter, by David Bodenhamer, outlines the implications of GIS for the discipline of history. The author begins by complaining that many historians rarely use, much less embrace, GIS technology, but he forecasts that "GIS may have the most potential for breaching the wall of tradition in history for two reasons: it maps information, thus employing a format and a metaphor with which historians are conversant; and it integrates and visualizes information, making it possible to see the complexity historians find in the past" (222). Whether creating maps for academic papers or publishing a historical atlas, GIS provides a platform for examining history. Given the viewing flexibility of many GIS layers, the software enables views from multiple perspectives and scales, an ability historians often desire. Regardless, "one of the most cited impediments is the technology's awkwardness or inability in managing ambiguous, incomplete, contradictory, and missing data" (126). Fortunately, developments in GIS are gradually allowing better depiction of the dimension of time, while historical maps are becoming more readily available (from sources such as David Rumsey and the Library of Congress), and digital historical gazetteers are often providing anchors to uncertain places of the past. Bodenhamer sums up by noting that "historical GIS offers an alternate view of history through the dynamic representation of time and place within culture" (231).

In Chapter 10, Knowles postulates what Lee and other Confederate and Union commanders could see of the battlefield at Gettysburg. She notes that Lee, Meade, and other West Point graduates were schooled and practiced in the science of topographical mapping, and thus had well-developed talents for viewing and reading terrain. Few maps existed of this or other eastern battlefields before the engagements, so scouts and reconnaissance patrols could only report, and commanders could only understand, the situation as it could be seen. Identifying lines of sight and fields of vision is, therefore, vital for understanding Lee's and others' actions and reactions.

Curtis Musselman, cartographer and GIS coordinator of Gettysburg National Military Park, shared the data layers of the area in and around the park, including the current 3D terrain model. A second digital terrain model was necessarily created from georeferenced historic maps produced by post-Civil War army topographers. Both the historic and modern map layers were combined to develop viewsheds from points of prominence, such as Lee's position atop the Lutheran seminary on the west side of the village or the Union signalmen's position on a small hill known as Little Round Top. Overall, "the GIS viewsheds help one imagine what might have gone through the minds of soldiers and commanders that fateful day" 260).

The concluding chapter, by Knowles, Hillier and Balstad, sets an agenda for HGIS. While it is no longer surprising to see historians using GIS in their research, its full potential has yet to be realized. HGIS requires both quantitative and qualitative scholarship. Since GIS, in general, works best in an interdisciplinary environment, sharing duties between historians, geographers, economists, and demographers helps mix the best attributes of these fields and so results in better analyses and the creation of new knowledge. A major challenge ahead is to create institutional infrastructure for collaboration in HGIS. The authors also campaign for the GIS software companies to "provide options for representing uncertainty," to develop "a tool that automatically creates data source notes for maps" and to "calculate and represent spatial change over time more easily" (272).

The supplementary CD comes with a copy of ArcExplorer, four PowerPoint presentations, PDFs, animations, and map documents. The PowerPoint slide shows, with accompanying PDFs of the presentation notes, relate to Knowles', Bol's, Hillier's, and Cunfer's chapters. Cunfer also provides five time-series animations of southern Plains rainfall, cropland, and dust storms. In addition, a link on the CD takes the reader to Knowles' Web site which provides her classroom handouts, as well as scanned and georectified versions of Warren's 1874 map of the Battle of Gettysburg. Lastly, Hillier, Cunfer, and Bol share three map documents and their associated map layers (TIFs and shapefiles) with readers to learn more about their studies.

In summation, this is an excellent book that should be shared and promoted with our colleagues in History. While I have quibbles over the organization of its chapters, the text is to be highly recommended as encouraging further work in this realm. Because of this book, and other publications by Knowles, Hillier, Bol, Gregory, and others, I look forward to future publications in the use of GIS for History.

Terra Incognita: Mapping the Antipodes before 1600
By Alfred Hiatt
University of Chicago Press, 2008
298 pages, 8 color plates, 47 grayscale figures
Hardbound (ISBN 13: 978-0-226-33303-8)

Reviewed by: Jonathan F. Lewis
Benedictine University

Terra Incognita examines and explains the initial appearance and subsequent evolution of European perspectives on remote, unvisited portions of the globe. Covering the period from antiquity through the medieval epoch and into the period of global exploration, the book's eight chapters are arranged in chronological succession. While the chapters are of roughly equal length, the periods each covers necessarily are not.

Hiatt's initial chapter lays out his framework for presenting European representations of unknown lands, which he introduces by describing Abraham Ortelius' sixteenth century *Typus orbis terrarum.* This map's inscription on the massive continent thought at the time to dominate the southern hemisphere reads, "*Terra Australis Nondum Cognita,*" or "Southern Land Not Yet Known," a clear indication of the expectation that remote lands did in fact exist, even if their exact form and contents were unknown. As Europeans acquired new knowledge about remote regions, *terra incognita* gradually became *terra inventa* (discovered land) and *terra nondum cognita* (land not yet known). That is to say, it evolved from unknowable into places both knowable and places soon to be known.

Throughout his book, Hiatt consistently returns to four organizational themes. The first theme involves the political implications "of spaces and people beyond the known world" (8). These implications include both imperial ambitions and tests of faith, the former because the antipodes represented frustrating limitations on ambitious rulers, and the latter stemming from Biblical assertions that Christianity must be spread to all lands. This theological implication led St. Augustine to conclude that no territory (and certainly no people) existed beyond the insurmountable barriers of vast oceans and intense desert heat.

Hiatt's second theme covers the manner in which remote areas were described and depicted, producing a particular geographic or cartographic tradition. As knowledge of the world was handed down through generations, it was gradually supplemented by new knowledge, which led to the need to distinguish ancient from modern knowledge. For Hiatt, there is a clear and consistent, if not always smooth, line of thought extending from the ancient period through the early modern. It is characterized by ancient writings being retold and supplemented, not simply to preserve the originals, but to give them prolonged credibility by making them appear to foretell subsequent discoveries.

The third theme explores periodization, and Hiatt's conviction that conceptions of the world do not easily fit standard period delimiters. He observes that, while change did occur, "[W]hy that change occurred will not be enlightening if it falls back on banalities about inherently "antique," "medieval," or "modern" ways of viewing the world" (9). For Hiatt, the medieval period witnessed not the end of a view of the world informed by ancient writers, but rather a dialogue with older texts carried out by medieval translators challenged to explain (or explain away) positions taken by esteemed writers such as Virgil. Later, as European explorers encountered new regions, their attempts to map it were heavily informed by the very traditions that had deemed these areas forever inaccessible.

The book's final theme is one of representation. Many of the chapters examine the necessarily speculative graphic representations of unvisited and/or unreachable *terra incognita* lands that were devised by European cartographers and explorers over a period spanning hundreds of years.

The convergence of the four themes is exemplified by the medieval reinvention of Cicero's ideas via Macrobius and his subsequent translators and critics, thus allowing an ancient perspective to make its way into much later and, presumably, more knowledgeable periods.

The map of Macrobius illustrates Cicero's theories; it was produced for a text written in the fifth century; there is reason to think that it was wholly or partially reconstructed in the tenth. It underwent significant adaptations in the twelfth century, and a revival of interest in the fifteenth as a result of humanist interest in Cicero. Is the map classical, late antique, medieval, or Renaissance? Does it not rather belong to any period in which it was reproduced? (11)

Given Hiatt's objectives, the early chapter "The Antipodes in Antiquity" represents an important foundation for what follows. In it, he examines texts produced during the period and the political and social significance of distant, unreachable lands. He introduces the antipodes by reviewing texts of classical writers convinced not only of Earth's sphericity but also its likelihood of being widely inhabited. Plato, in particular, is cited as having set many terms for subsequent discussion, including a test of basic intelligence and reasoning based on explaining why people living on the opposite side of the planet would not see themselves as upside down. Later, Crates of Mallos offered what came to be a popular depiction of Earth divided into four regions, whose remote residents were identified by Geminus as *periokoi* (inhabitants of the northern portion of the western hemisphere), *antoikoi* (those living in the southern portion of the eastern hemisphere, i.e. Africa), and *antipodes* (people dwelling in the southern portion of the western hemisphere and whose feet were, thus, opposite our own, inspiring the region's name). The central reference point for these regions, of course, was *oikoumene* or *ecumene,* the known world of the Mediterranean, Europe, and western Asia. Once accepted, these regions represented opportunities for political commentary and were particularly useful for characterizing the foolishness of ambitious emperors intent on world conquest, given the impossibility of reaching, much less subduing, remote outlying areas.

From there, Hiatt proceeds to describe three major writers whose works preserved classical formulations of remote and unknown regions of the world: Augustine of Hippo, Macrobius, and Capella. Describing the views of each in detail, Hiatt characterizes them as either receiving and rejecting the ideas of the classical period (Augustine) or receiving and embellishing them in ways that affected later understanding of the classics (Macrobius). Hiatt then moves to graphic depictions of unknown regions, particularly as these were informed by the writings of classical authors and their translators. This section introduces zonal maps into the discussion in order to analyze how areas lying in and to the south of the unbearably hot zone, within and to the north of the excruciatingly cold zone, and to the west of a vast and unnavigable ocean were characterized. Informed by longstanding legends and by tales from travelers who claimed to have visited some of these areas, cartographers occasionally populated such regions with monstrous races. What prevailed from the ancient into the medieval periods, then, was uncertainty about places beyond the *ecumene.* The antipodes had to be explained or explained away in a debate that was largely theoretical. Before long, however, "[P]eople began to challenge the impermeability of the barriers between known and unknown worlds"(89).

By the fourteenth century, translations of Arabic texts had raised doubts about the impermeability of southern regions. These doubts were amplified in the fifteenth century with the translation of Ptolemy's *Geographia* and led to a reconceptualization wherein the antipodes came to represent "the failure of states and their rulers to push at the barriers of knowledge" (96) This led in turn to new evaluations of received texts and to wholly new speculations as well. Significantly, confirmed discoveries of new lands did not introduce devastating challenges to old systems of knowledge. After all, Augustine had said only that God would not have put people in regions that were inaccessible. Clearly, his error lay only in believing that insurmountable barriers existed, an observation accepted by the ancients, not in the position he had derived from scripture. Now that it was known that humans in fact dwelt in previously unknown areas, the work of evangelization should continue because "the head of the Church was charged with the apostolic duty of promoting the spread of the gospel to all peoples" (159). Unknown land was thereafter increasingly defined as land where the name of the savior was unknown and, thus, where the duty of Christian explorers was to redeem the residents by bringing them into the flock of the faithful.

Hiatt examines various European explorers' encounters with the Americas in order to show the coexistence of old ways of thinking alongside new. Columbus, for example, is mentioned for having continued to believe he had reached Asia, displaying the resilience of the perspective that all land formed one vast continent. This is in contrast to Vespucci's conclusion that the new continents were not at all connected with the Old World. Hiatt shows how the insular perspective was again given a new lease on life with the discovery of Antarctica merging with early reports of Australia to produce maps depicting a vast southern continent, *Terra Australis.*

The enormous southern continent was quickly recognized as an opportunity to exonerate old systems of knowledge. Not only did it connect major land masses into one territory, as the insular perspective required, it also offset the weight of northern land masses, something the ancients had insisted was required for Earth's rotation to remain stable. Thus posited, early observations were seen as corroborations that only slowly came to be reevaluated with the introduction of new information. Even then, however, *terra incognita* continued to exist, only displaced toward the interior of lands whose coastlines had been mapped.

Hiatt devotes considerable space to the evolving cartographic treatment of *Terra Australis*, whose falsely depicted vast dimensions remained in place well into the seventeenth century. Such large, unknown areas also afforded cartographers blank surfaces to display additional information about the European conquerors, whose superior knowledge systems, advanced technology, and omnipotent deity had come to encompass the entire planet. These descriptive texts and graphics, in turn, provide additional data to Hiatt concerning the purpose of areas soon to be explored and brought under subjugation.

In his conclusion, Hiatt asks us to view *terra incognita* as expressing "the ignorance that accompanies dreams of world expansion, of universal reach, always receding into the distance."(253) The term represents an elusive quest for knowledge and the control that knowledge brings. Utilizing sources from several major libraries and cartographic collections, displaying dozens of key illustrations, and having command of several languages, Hiatt makes of *Terra Incognita* a well reasoned, solidly documented case that is both organizationally and stylistically well constructed. Chapters begin with useful prefatory remarks describing what is to follow and end by persuasively showing how developments in that chapter prepare the ground for its successor.

Convinced of his own view, Hiatt's reasoning and documentation are uncharacteristically thin in one or two spots. For example, in his discussion of extensive text being placed on depictions of *Terra Australis*, where he focuses closely on one particularly crowded cartouche, his frustrations lead him to assert that "such is the illegibility of the words in these panels when seen from any distance that one must conclude that the multiplicity of text . . . is designed to be seen primarily as a whole, and not read. Or rather, that instead of being a display of text intended to be read, it is intended to be read as a display of text"(232). He seems here to confound effect with intent; other paleographers often struggle with documents having extremely crowded, nearly illegible text bodies without reaching similar conclusions. Similarly, although Hiatt acknowledges that there is little surviving evidence that Ortelius gave much thought to the southern continent, he suggests that Ortelius might have thought of *terra incognita* as part of "the scorned world" because recent studies have linked him with a neo-Stoic religious group and neo-Stoics were known to have distinguished "scorned" from "adorned" portions of the world (234). Such stretches are few, though, and not entirely without foundation.

Terra Incognita is a solid research effort reminiscent of the sort found in the University of Chicago Press's multi-volume *History of Cartography*. Like that series, a separate volume will be needed to document non-European treatments of the same topic. For the period and subject matter identified by its title, *Terra Incognita: Mapping the Antipodes before 1600* is the definitive word on the topic. In that regard, Hiatt comes to resemble some of the medieval translators he describes early in his book, who both transmitted and enhanced the earlier sources they were reviewing and thus contributed to an ongoing cartographic tradition.

Understanding Place: GIS and Mapping across the Curriculum
Diana Stuart Sinton and Jennifer J. Lund, editors
ESRI Press
272 pages
$49.95
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Reviewed by: Dr. Nicolas Karanikolas
Aristotle University of Thessaloniki

Reviewing a book always is a good opportunity to go one step further than just reading. You have to think like the writer, the publisher, and, of course, the reader.

Reading, according to Umberto Eco, is like "living more" through the writer's thoughts, and we can agree that a good book is the book that guides you to new thoughts, new images, and finally to new places. *Understanding Place*: *GIS and Mapping across the Curriculum* is a book that succeeds on this concept. The editors, Diana Stuart Sinton and Jennifer L. Lund, have done excellent work with the help of a big number of writers. Thirty-six writers sign the nineteen chapters of this book, and they give us something new: a holistic approach about the use of GIS and mapping in teaching, learning, and researching across many subjects from liberal arts to humanities.

Reading this book helps one to understand that map making and map reading are not mechanical activities but aspects that need communication skills. GIS today provides the controls of how, when, and where all information will be displayed. That's why maps and GIS are valuable in a teaching and learning environment (Medyckyj-Scott and Hearnshaw 1994).

The structure of the book is divided in two basic parts. In the first part of the book, five chapters reference one of the basic issues for so many instructors: how to teach students to think spatially. In this main part, many professors write about the way they use GIS to help students to think and learn in a more spatial way.

Terms like distance, proximity, and pattern recognition are some of the main subjects which interest instructors today. Basic geographic terms, like how to transform a data matrix into a map and by this change view and analysize scales in order to come to different conclusions, are also some of the basic aspects of this part.

Students who work with GIS learn to explore new ways of thinking and knowing. By using maps and geographic systems, they develop new skills of thinking with information images and become intelligent consumers of visual information and effective communicators with maps. They can actually learn to organize their thoughts for complex issues of their studies as layers of a geographic information system.

In Chapter 2, "About that G in GIS," Diana Stuart Sinton and Sarah Witham Bednarz make a very interesting observation about "[h]ow maps, mapping and GIS can help students become spatially aware and appreciate the impact that geographical location has to influence about everything." This remark can drive us to think of GIS as a basic need and a powerful tool of analysis in our complex, multidimensional world. According to the authors, everything in our memories is connected with *where*. Using the image of *where*, we bring back a recollection of *who* and *what*. Thus, spatial thinking has tremendous potential in the pedagogical process. But is it enough to simply make use of a software package? Are software skills all that is required in learning to think spatially and to answer or analyze sophisticated, spatially based questions? According to the writers there is a lack of training among college faculty members themselves to think, live, analyze, and synthesize spatially based questions. Fortunately, Internet-based mapping, new capabilities of software packages (like time-based representations and analysis), and, above all, the importance of spatial thinking itself may one day drive us to spatial-thinking standards in our education.

In Chapter 3, David Staley discusses the use and need for map making in history classes. One of the basic ideas of the chapter is to understand maps as theaters of historical events and phenomena: to see that "All maps contain stories, diachronic or synchronic, temporal or spatial." The relation of geography, history, and cartography has always been strong, and it becomes even stronger with the use of technology and GIS.

In Chapter 4, Jennifer J. Lund describes the basic relationship that exists between socioeconomic data and the quantitative analysis available through GIS. Can discovering the satisfaction of posing a question, getting an answer, and immediately perceiving its import encourage students to work harder?

By teaching students how to map complex geographic data, we give them a tool to comprehend relationships within any multidimensional system of society.

Chapter 5 is the final chapter of the first part of the book. In it, Melissa Kesler Gilbert and John B. Krygier provide examples of GIS projects initiated at small, liberal arts colleges. The Ohio 2001 GIS project, for example, which involved faculty, students, and city residents, developed a system of networked bicycle paths. Other projects from Carleton College, Grinnell College, Macalester College, Middlebury College, and Swarthmore College are also described. Conclusions of this interesting chapter come to prove that GIS community work in higher education could be informed and enhanced by the innovative pedagogy of service learning. From this chapter the reader can get new ideas for similar projects in his or her own neighborhood.

In the second, and final part of this book, fourteen chapters focus on GIS case studies in the curriculum.

The basic question, in the first six chapters of the second part, is the relation between the social sciences and place. Although social scientists have recognized the significance of place in human behavior for many years, GIS and today's technology offers many new tools to their science. That is why, in many colleges and ever more undergraduate courses, complex GIS software is used by students. There is a close connection between research from these new technologies and previous knowledge in social sciences.

Undergraduate students of social science background are encouraged to learn and work with GIS, where they can begin from the amazing (for them) portrayal of spatial information through maps and continue on to make all the spatial analysis by themselves. By examining "social puzzles" in space, they discover evidences of social phenomena and their relation with natural and human space.

In Chapter 7, James Booker from Siena College in New York explores the relation between economics and space at different scales of analysis, from global to local. According to the writer of this chapter "What GIS can best offer economics is access to the data itself, a tool to manipulate data mathematically and iteratively." Many examples of this are offered in his article. Gross domestic product (GDP) per capita for the whole world, African railroads, and the location of Japanese auto manufacturing facilities in Flint, Michigan, are a few of the examples of economic variables which are analyzed through GIS. Related economic variables are also used as examples of GIS capabilities. U.S. federal lands and population pressure, unemployment rate by state, comparison of household income in the New Orleans area prior to and after Hurricane Katrina, and tax maps using hedonic models on parcel land values are some of the examples that prove that the relationship between space and economics allows GIS to be used to discover faster and more accurate methods of analysis.

In Chapter 8 the main question is the use of GIS as a tool in anthropological research. The example for this chapter comes from Republic of Guinea and the area of Kissidougou. The question is: can we appropriately map the human geography of the Guinea Savanna? According to the student research, GIS can have an important value for anthropological research because we can analyze interactions within the human environment of one area against the differing but equally valid situation in other areas.

Political scientists Mark Rush and John Blackburn discover the GIS abilities for quantitative analysis through their course at Washington and Lee University. In Chapter 9 they discuss the legal and academic background of the redistricting process and law and how that can integrate GIS instruction.

In urban studies GIS has a major part, especially in analysis and mapping of spatial data. How students can use GIS to present and organize a problem, define what they know (and what they don't know), and finally summarize their findings is discussed in Chapter 10.

Archeology is a subject in which GIS can be utilized to generate the substantial, collective knowledge that fuels an archaeologist's instruction. In Chapter 11, Pedar W. Foss and Rebecca K. Schindler give us an example of teaching a multi-institutional course that contains a field component, an online learning component, and construction of a major research database at Collaboratory for GIS and Mediterranean Archeology (CGMA) in DePauw University in Greencastle, Indiana.

In Chapters 12 to 15 the relation between GIS and natural sciences and phenomena is represented. How GIS can support research and teaching in natural sciences or model and represent natural phenomena are the main aspects.

In biology for example, GIS can be used, according to Chapter 12, to help students consider interrelated factors that influence the abundance and distribution of organisms, communities, and ecosystems. Benefits of GIS in sampling and visualizing data, and especially mapping of ecology with the use of GPS and GIS, are discussed in Chapter 12. In Chapter 13 the modeling of the Maine lakes environmental area is studied, while in Chapter 14 a different scale approach is used to investigate soil erosion and deposition in the lab and field. Geology is the main field for integrating with GIS in Chapter 15, where the longterm hydrologic impacts of land-use change, and ways of relating GIS with geosciences, are the main objectives.

In Chapters 16 and 17 the spatial thinking is focused in the arts, humanities, and languages. In Chapter 16 French society and culture is connected to sociology and geography with the use of GIS, and architectural heritage is mapped in Chapter 17, where historical geography is the frame of discussion.

GIS is of great importance in a religious study, where the exploration of pluralism and diversity are analyzed in New London. Mapping this religious analysis and comparing it with other factors like income or Hispanic and English population are presented with the use of GIS.

In the nineteenth and final chapter of the book, Jennifer J. Lund maps musicology and musicians. Music diaspora as a factor of cultural diaspora proves the advantage of geographical analysis of musicology.

After finishing this book, readers cannot help but find themselves with new ideas about the use of GIS in their fields, regardless of theirsubjects or positions. Diana Stuart Sinton and Jennifer J. Lund manage to cover so many things in this one book that they truly prove the real "place" of GIS in the curriculum: It is anywhere, and it is everywhere.

Reference

Medyckyj-Scott, David, and Hilary M Hearnshaw, ed. 1994. *Human factors in geographical information systems.* Hoboken: Wiley.

Cartographic Collections

The University of Georgia Libraries Map Library

Hallie Pritchett
Map and Federal Regional Depository Librarian
UGA Libraries

My introduction to the University of Georgia Libraries Map Library came in September, 2006 via the MAPS-L listserv, where it had been reported that early one morning an underage drunken driver had crashed his car through the wall and wound up inside the building (Figure 1). Fortunately no one was hurt, including the driver; he was found wandering a mile or so down the road, no doubt wondering where he had just parked his car. Aside from the sheer fascination of seeing a car in the library, having recently applied for the map librarian position at UGA I was much more interested in getting a look at the Map Library itself. I spent quite a bit of time looking beyond the crumpled car and the bricks, road signs and shrubbery that came in with it and focused instead on the rows of map cases and atlas shelves in the background. Despite the damage to the building, it looked like a pretty impressive place.

When I arrived in Athens in February, 2007 as UGA's new map librarian, I discovered that the Map Library is indeed a very impressive place. Comprised of approximately 630,000 items including maps, air photos, atlases and cartographic reference materials it is one of the largest academic map libraries in the country. The collection focuses on cartographic resources from the late 19th century to present day with a particular emphasis on the State of Georgia (Figure 2). An equally impressive but considerably smaller collection of historic maps dating back to the 16th century resides in the UGA Libraries Hargrett Rare Book and Manuscript Library (http://www.libs.uga.edu/darchive/hargrett/maps/maps.html). Like many large academic map libraries the core of the UGA Map Library's collection includes a substantial number of World War II surplus maps including captured maps from both Nazi Germany and Imperial Japan. These maps were donated to the Geography Department in the 1950s; the collection was transferred to the Libraries in the late 1960s. The Map Library was originally housed on the second floor of the Science Library; when load-bearing issues became a concern it was moved to the basement of that building where it remained until 2005 when the space it occupied was converted into a server room for the University's Computer Center. It is currently located in an off-campus warehouse that adjoins the UGA Instrument Shop and sits across the street from the Repository, the Libraries' off-site storage facility.

Over the 40-plus years since the Map Library became part of the UGA Libraries the collection has grown enormously. In addition to the World War II maps, the collection includes a wide variety of thematic maps, map sets and atlases from around the world, with an emphasis on the U.S. and the State of Georgia. As UGA is a regional depository library for U.S. government documents, the Map Library holds current and historic U.S. Geological Survey topographic maps for the entire U.S. and its territories as well as other thematic maps published by USGS. It maintains the largest collection of aerial photography of the State of Georgia outside of the National Archives with approximately 230,000 photos from the late 1930s through the late 1980s; approximately 50,000 of these photos are available online through the Digital Library of Georgia (DLG) (http://dbs.galib.uga.edu/gaph/html/). Sanborn Fire Insurance Maps for Georgia cities and towns from 1884-1922 scanned from the collection are also available online through the DLG (http://dlg.

galileo.usg.edu/sanborn/); the Map Library holds the original paper and microfilm versions of the Sanborn maps through 1985. It was also one of the first map libraries to acquire Soviet military topographic map sets after the fall of the Soviet Union, with holdings for most countries in Africa, Asia and the Middle East as well as parts of Eastern Europe. One of the more unusual items in the collection is a Denoyer-Geppert moon globe, ca. 1970, which was borrowed from the Map Library for the 1995 movie "Apollo 13" and used as a prop in an early scene where the astronauts have their official pre-flight portrait taken in their space suits (Figure 3).

Although we see fewer UGA-affiliated users now than when we were on campus, the Map Library still attracts many non-affiliated users who are mostly interested in our Georgia air photos and USGS topographic maps. Because the collection does not circulate, we offer a wide variety of color copying, scanning and printing options, including large-format scanning and printing, which allows our users to reproduce almost any item from the collection in either paper or digital format. Our current off-campus location compels us to find different ways to make cartographic resources available to our users, particularly those who may not be able to visit the Map Library in person. We maintain an extensive Web site that includes links to a wide variety of online cartographic resources (http://www.libs.uga.edu/maproom/). UGA students, staff and faculty can request that atlases in good condition be sent to an on-campus library for in-house use. Several scanning projects are underway to make our historic 15- and 30-minute USGS topographic maps of Georgia and historic USDA soil survey maps of Georgia available online through the DLG; these maps will start appearing there by fall of 2009. Many of our historic Georgia highway maps dating back to the 1920s have also been scanned and are available through the Georgia Government Publications database (http://www.galileo.usg.edu/express?link=ggpd). Also, in the interest of publicizing the Map Library on campus over the past two years we have mounted several well-received displays of World War II maps and Sanborn maps and air photos of the UGA campus in various libraries; plans are in the works for a larger display of maps of Georgia in the coming year that will involve all of our on-campus libraries.

With the completion of the Libraries' new Special Collections building in 2011 the Map Library will move back to campus, taking over space in the sub-basement of the Main Library currently occupied by the Richard B. Russell Library for Political Research and Studies. Upon its return to campus, plans call for the Map Library to be combined with the government documents collection to form a new map and government documents library. This combination promises to be an exciting new chapter in the Libraries that will allow us to provide new and enhanced services such as GIS that take advantage of resources from both collections. In preparation for this move, Map Library staff members are working to purge duplicates from the collection and eliminate the map cataloging backlog that has accumulated in recent years. Souvenirs of the 2006 car intrusion – including a battered supply cabinet, some scratched and dented map cases and a large yellow road sign – will accompany the collection and serve as mementos of its time off campus. But for now we continue to conduct business as usual, safe behind the new guard rail that was installed a year ago after another car driven by a different underage drunken driver sideswiped the building and almost hit the gas main. After more than two busy and rewarding years here I can safely say there is never a dull moment in the UGA Map Library.

The Maps Collection of the National Library of Australia

Dr. Martin P. Woods
Curator of Maps
Australian Collections and Reader Services

Introduction/brief history

The National Library of Australia was established at Federation in 1901, when the British colonies merged as a nation with their own constitution. In those days the parliament was located in Melbourne, the nation's interim capital. The Library commenced with a clear national purpose in mind, its primary function to provide politicians with material for speeches. With deliberate intent, the collection grew to record national progress, thus beginning a process of interpreting the nation's particular place in history. National libraries may be distinguished by their maps collections, which encapsulate internal geographic limits and define a nation's relationship with nearby countries and the rest of the world. While map curators have their eyes set on the present and future trends in cartography, history has an indisputable place in such collections.

The place of Canberra in Australia's history and development was confirmed in December 1909, with the Seat of Government Acceptance Act (Cwlth). Then began a period of intensive planning, surveying, and mapping for the new capital, including an international design competition that produced eighty-one design entries and literally thousands of plans and topographic maps. This culminated in the opening of Parliament in 1927, on the Molonglo Plains in southern New South Wales. It is surprising then, given the importance of maps to the nation's planned origins and the proximity of the Parliament to the Library, that the Maps Collection did not exist as a separate entity until 1962. Its existence owed something to the cartographic self-awareness of the 1950s and 1960s, when new methods in quantitative geography saw the emergence and growth of university geography departments. Neither was its development merely coincidental with the formation of public cartographic societies, including the Australian Map Circle (now the Australian and New Zealand Map Society), with whom it has shared personnel. Above even these external demands, the Library was impelled to face a growing problem-- how to manage all those maps?

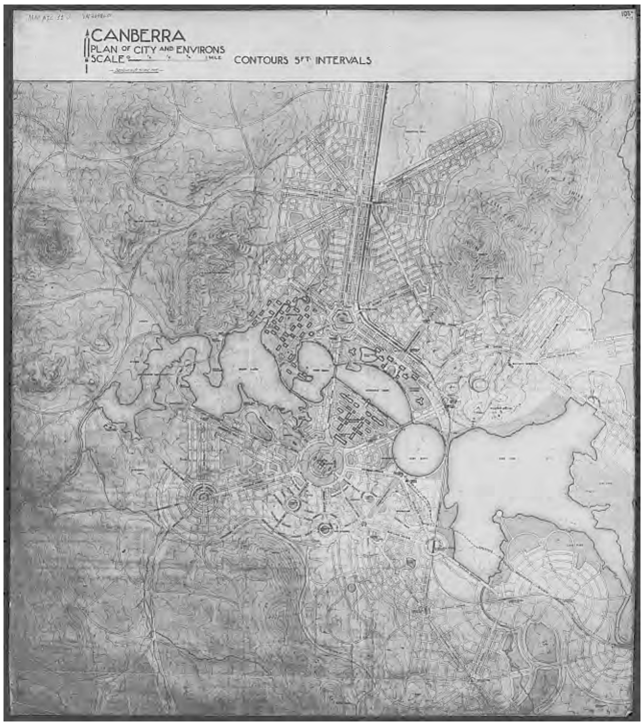


Figure 1. Walter Burley Griffin (1876-1937). Canberra plan of city and environs, *part of* Eric Milton Nicholls special map collection, *1916.* *(see page 90 for color version)*

Positioning of Maps within and outside the National Library

The Maps Section is one of six specialist materials collections within the National Library, each an independent entity, though integrated with the Library's mainstream processes. As one of the Library's key research collections, Maps benefits from the Library's promotional opportunities and leverage, but may be subject to tensions when larger book management and other processes are considered. Maps at the National Library, while comparable with other large map collections, has rather less in common with university map libraries, especially those with geography departments to service. The absence of a direct departmental client group to shape collecting or access strategies does not absent Maps from providing resources and services of value to maps users, but it does shape the nature and content of the services provided. The challenge in common with all maps libraries, that of demonstrating value in a competitive administrative environment, is as ever a key driver.

A further dichotomy is evident in staffing arrangements that are spread across the Library's divisional (functional) structures. Maps and other collections, Manuscripts, Pictures, Oral History, and Music and Dance, are positioned within the Australian Collections and Reader Services Division, with acquisition, access, stack management and promotion of the collection the overall responsibility of the Curator of Maps and a small core team. The important cataloguing, digitization and preservation functions are the responsibility of the Collections Management Division. The services of these teams are negotiated through ongoing meetings and annual budget processes and reviews. It is no small point that the interests of Maps are dependent in large measure on good working relationships with each of these functional areas.

Equally, it has been important for successive curators to pay close attention to the Maps' profile both within and outside the Library. The "curatorial model" at the National Library, which has historical antecedents, allows communication with key collecting sectors, makes use of technological partnerships, and is sensitive to opportunities. Some time has been spent on reclassifying and branding staff positions to give better effect to initiatives that are uniquely "Maps" and to enlist support for specialist initiatives in terms of access, information technology, preservation, publications, and events.

One forthcoming opportunity connected to the redevelopment of the Library's Treasures Gallery next year will be a showcase exhibition for the Maps collection, planned for the Gallery in 2012. Online exhibitions, including the National and State Libraries

Australasia (NSLA) initiative *South Land to New Holland: Dutch Charting of Australia 1606–1756* (2006) may be inter-library efforts. Our own occasional "White Gloves," and other displays and events, are often coordinated with public participation and the involvement of the Friends of the Library. Maps generates its own daytime or after-hours involvements and provides tours for donors, visiting curators and librarians, or genealogical, historical and geospatial organisations. These are high priority events, demonstrating ongoing research value and donor relationships. Further *ad hoc* media work and presentations to groups are generated by corporate Library initiatives, and in the past few years we have had regular contributions to Education and Visitor Services tours. All of these efforts are very time-consuming, and it is necessary to prioritize and measure involvement.

The role of the Curator of Maps also includes a number of *ex-officio* and supplemental roles that accrue ongoing status and networking benefits to the Library. External stakeholder representational work may range from engaging with cartographic societies and support networks to more practical national coordination of data and standards, while each contributes to the profile of Maps in areas of antiquarian, historical, and geospatial research.

Figure 2. Hands on maps Maps, "White Gloves" event, 12 March 2008.

Building the collection

The aim of the collection, according to the Library's collection development policy, is to accumulate "Australian and overseas cartographic materials, which form part of the documentary record of Australia and reflect its relationship to the rest of the world." While this prosaic formula is designed to reflect ongoing acquisition, the National Library has a collecting history pre-dating its existence, thanks to the zeal of individuals who had spent a lifetime acquiring material for their print collections. The Maps Section Collection owes its strength and diversity to the activities of four individual collectors. The first of these, Edward Augustus Petherick (1847–1917), arrived in Australia in 1852 with his wife and family. Employed by Sydney bookseller George Robertson, Petherick soon developed an interest in Australiana. He collected books, manuscripts, ephemera, and maps, and in 1887 founded the Colonial Booksellers Agency in London.

Petherick's collection, which he first offered to libraries in the Australian colonies of Victoria and New South Wales in 1895, comprises works on the geography, discovery, exploration, and natural history of Australia and Polynesia. He fervently believed his collection could become the nucleus of an Australian national library and emphasized the need for continuing acquisitions after it had been deposited. His collection of 1220 maps and nearly 300 atlases accounts for a substantial part of the National Library's rare maps collection, now numbering more than 11,000 items.

Like many collectors and writers of the late nineteenth century, Petherick was preoccupied with the cartographic origins of Terra Australis, a subject of ongoing interest to Australian and other scholars. As a consequence, the Petherick Collection comprises many early maps of importance to the European charting and, significantly, a large component of the relevant output of the Dutch Vereenigde Oost-Indische Compagnie (VOC, or United East Indies Company). In a similar fashion, the New Zealander Rex Nan Kivell (1898-1977) bequeathed more than 1000 sixteenth and seventeenth-century Dutch, French, and British maps tracing exploration in the Indian and Pacific Oceans. The acquisition of a large proportion of the collection of the collector R.V. Tooley (1898-1986) in 1973 added immeasurably to the Library's holdings of early Australian, Asia-Pacific, and Antarctic maps.

Turning inland, the colonization of Australia was the particular focus of the eminent judge, collector, and bibliographer John Alexander Ferguson (1881-1969). Ferguson's cartographic interests lay in material relating to church and mission-station history in Australia and the Pacific, and in cadastral maps of New South Wales. Ferguson's collection of 911 maps and more than 7000 estate sales plans reflects his interest in the processes of subdivision and settlement, contributing an invaluable record of land ownership patterns throughout the nineteenth century.

During the twentieth century, government mapping agencies including the Royal Australian Navy, Australian Army and the Division of National Mapping (later Geoscience Australia), together with many state and territory map producers, have deposited large collections of maps which could not have been easily obtained from other sources. Significant institutional additions, including the aerial photography of

Royal Australian Navy, Australia, and Antarctica, have contributed to a national collection now comprising some 600,000 maps, 20,000 atlases and over 800,000 photographs.

Over time, the Library has also benefited from its agents in Indonesia and London and from the connections that particular curators have managed to utilize when duplicate maps have been offered. A notable example was an extensive collection of topographic series mapping of Southeast Asia, obtained from the British Ministry of Defence's Singapore map collection, hastily removed to Britain as the Japanese advanced through Malaya.

In addition, Maps acquires smaller "formed" collections, comprising sometimes the output of a single publisher, collector, researcher, or organization, where the historical or evidential value derives not only from the information contained in the individual items but also from the context, including the physical connections that existed between some or all of the items. Collections such as those of anthropologists, surveyors or hydrographers, and organisations such as the Australian Antarctic Division may be kept as they were used during their active life to preserve the integrity of the whole collection.

Current acquisition

The Library's broad collecting intention is to continue to collect most of the printed material covered by the legal deposit provisions or by the various arrangements applying to government publications. The result is a comprehensive, though not exhaustive, collection of material capable of supporting in-depth research in Australian studies. As others have observed, a truly national collection of maps is unachievable, at best asymptotic, since the resources available may never approach the sum of all maps. The life cycle of a map housed at the Library begins with its selection on the basis of a collection development policy, a document of long standing with this library, and one that has basic elements in common with the community of Australian libraries, most notably the NSLA. For the National Library, overseas collecting is added to the focus on Australian materials. The policy statement defines the scope and nature of the collecting of Australian and overseas materials within the Library and is reviewed with public input to provide a practical interpretation of the Library's legal obligations under the National Library Act of 1960.

In selecting items for the collection, Library staff members consider how well the item adheres to the collection development policy, taking into account aspects such as subject area, geographical coverage, cost, physical characteristics of the item, its ongoing need for preservation and relationship to the existing collection, as well as other agencies' collecting responsibilities. Material commercially or privately published in Australia is collected on legal deposit under the provisions of the Copyright Act 1968. The Act requires all Australian publishers to deposit a copy of "library material," including "maps, plans, charts and tables." In fact, acquisition through deposit is dependent on regular communication with publishers, a time-consuming process if left to Maps staff to make personal contacts with government agencies and commercial publishers across the country. Add to this the Library's collecting interest across Asia and the Pacific, where there is no compulsion to deposit, and the available resources are spread thin. Such communications may involve creating a list of map producers in a given jurisdiction, identification of items that should have been deposited, correspondence with map producers explaining why it is desirable or necessary to deposit material in the National Library, and asking for all maps, including the identified missing maps, to be sent. Follow-up is done when time is available to check on material that has not arrived.

In reality, attention to jurisdictions may be patchy, and may rotate over years, and, even where communication is more regular, problems often arise. While the maps cited as examples in the claim letters often arrive, the Library generally receives only a portion of other material from the vendors. Because government departments are frequently restructured, it is substantial work to recreate a list of map producers every few years. And, the follow-up process has rarely been undertaken.

In recent years the Library has supplemented this labor-intensive process with automated prompts generated through the national resource sharing service "Libraries Australia," coordinated by the National Library for Australia libraries and their users. It is used for reference, collection development, cataloguing, and interlibrary lending. The heart of Libraries Australia is the Australian National Bibliographic Database (ANBD), which records the location details of over 42 million items held in most Australian academic, research, national, state, public, and special libraries. Alerts are generated when Maps are received into other libraries that are not held in the National Library and are forwarded to Maps staff. In addition, these alerts are added to its local integrated library management system (ILMS–since 2000 this has been Endeavor's Voyager), and, if not received by a pre-set date, automatic updates are sent to the vendors.

Cataloguing progress and projects

The importance of bibliographic control for maps within such a large, cooperative, and integrated environment as the Australian National Bibliographic Database is self-evident. The Library developed its own catalogue interface in the mid-1990s, and it remains the number one entry point for users to the Library's Web site. Increasingly, and as reliance on resource discovery via search engines proceeds unabated, the MARC bibliographic record provides a reliable standards-based venue for information about maps and how to find them.

Where possible, the goal of the maps cataloguing team is to create catalogue records at item level for all incoming maps. Several retrospective projects have addressed gaps in the record. In the Maps Reading Room every second or third enquiry seems to require a cadastral map to provide at least part of the answer. Australians have a great thirst for knowledge of their local communities, family properties, cemeteries, public buildings, and landmarks. Cadastral maps provide a great deal of useful information, usually including lot and section numbers and names of original owners, which form the basis of many family history enquiries. Since the early 1990s, National Library map cataloguers have been systematically working through the cadastral maps of each state and territory to provide simple, straightforward access to all the parish and county maps. At the end of May 2008, the staff completed cataloguing the more than 7000 parish maps and over 100 county maps held of New South Wales, the last of the states and territories in this retrospective conversion project. In addition to providing thousands of parish and county names to the Library's catalogue and National Bibliographic Database, by working closely with our Map Reading Room staff, the map cataloguers have addressed the major barriers to easy access of this set of heavily-used maps.

By contrast with this category of maps, the collection of some 400 rare atlas volumes ranging from several early Ptolemy editions to the beginnings of Australian publishing in the mid 1800s are specialist items. Each contains map sheets otherwise opaque to the end-user. Canberra is blessed with a large community of retired public servants and long-term Library users who express their interest in the Library and other cultural institutions situated on Lake Burley Griffin. The Library has fostered links with the community through its Friends of the Library Group, and many volunteers have emerged to make significant contributions to our understanding and control of the collections. One important project has been the translation and description of individual map sheet titles through a spreadsheet translated to the catalogue following checking by cataloguers. The project has the added benefit of providing the Maps curator with quick information on items offered by vendors that may indeed already have a presence within these volumes.

Control of series maps

In days of ongoing efficiency dividends, the Library's fiscal base has been discounted annually, heaping pressure on areas to demonstrate worth, increase numbers against annual scorecards, and find new ways to deliver services. Maps is one of the collections for which substantial cataloguing progress has been made over the past ten years; however, it has to be recognized that maps in series continue to present libraries with a challenge beyond means, at least if control at item level is the goal.

At the beginning of 2009, the proportion of the National Library's printed collection estimated to be in the online catalogue was 89 percent, while the figure for Maps (very much an estimation) was 32 percent, of which the vast majority are series maps. Recent attempts to address large series have faltered somewhat, though the Library determinedly presses on with item-level coverage of all Australian maps within series. There is no question that the same could be said of the considerable holdings of Maps for Southeast Asia and the Pacific, for which the Library also has a collection responsibility. The Library holds major topographic series, either partial or complete, for in excess of 100 editions pertaining to the region.

Here the approach can only be to create unified collection records and provide series indexes where these are available. Most recently, these have been added to the catalogue record as a visual aid, beginning with the major Australian series and now progressing into the Asian series.

A similar expedient is applied to the 800,000-strong aerial survey photographs collection in a cataloguing project begun in 2005 and now nearing completion. The aerial photographs far exceeded the resources of the Maps cataloguing team complement. The collection consists of Commonwealth photography flown by the Royal Australian Air Force (RAAF), Division of National Mapping, and other agencies since the late 1920s. They are arranged and indexed according to the Australian topographic sheet numbering system. This near-comprehensive depiction of the Australian landscape is a well-used and valuable record of how the land has changed over time. Geologists, mining and exploration companies, developers, planners, environmentalists, farmers, soil conservationists, and land care groups use aerial photographs as a means of monitoring land clearing and forestry development.

The strategy developed was to seek out short-term staffing as funding allowed, together with volunteers who contributed data via spreadsheets. A spreadsheet was created for each state and territory, prescribing mandatory field information required to generate a bibliographic description at map grid level, so that retrieval would be the same as for the equivalent mapping (in this case the majority were 1:63,360). The fields then recorded included the grid title and number, dates flown, coordinates, and run numbers covered. Where available, reference was made to print or online flight diagrams maintained by Geoscience Australia embedded in the spreadsheet and ultimately in the catalogue record. Once the particular state was completed, the spreadsheet columns were concatenated and loaded into the appropriate bibliographic fields. The process to date has created approximately 3,000 individual catalogue records, covering access to some 500,000 photographs.

Access to Electronic maps publishing

Maps libraries have been long aware of the trend from publication of paper-based maps to the provision of map data in digital formats, both in physical form and in databases. Review of Australian government suppliers to the National Library has revealed considerable variety of approaches to making maps and maps data available. While Geoscience Australia lists eleven series of mapping available only in paper format, it is also responsible for a diverse range of products from topographic (GIS) data and digital elevation models to thematic data. In addition, geological and geophysical products available include standard thematic maps, GIS datasets, databases, reports, and publications at both the regional and national scale in support of Australia's resource industries, environmental management, and so on. Geodetic data, fundamental to Australia's geographic coordinate systems and the spatial industry, is of immediate interest to a specialist technical audience.

Though it would be impossible for the National Library to collect and make available these datasets and related software, information provided on CD or DVD-ROMs is less problematic, at least on the surface. Hard format electronic map products are available across all sectors, including primary industries and environmental departments, planning, tourism, business, industry and other agencies, authorities, and map specialist companies.

At present, there is no legislative compulsion in Australia to deposit hard-format electronic media. This has the incongruous effect of adding to the manual burden of contacting suppliers and acquiring such electronic map products. The problem is compounded when cataloguing functions and access are considered. Many producers who supply maps on CDs and DVDs do not include usable metadata that may be related to existing catalogue records.

To some degree the pressure of collecting electronic map products is alleviated by the trend towards custom maps drawn on demand from vendor databases; however, the lack of any agreements securing ongoing preservation of old or legacy data by agencies has not been comprehensively addressed in the Australian context.

Although the National Library does not see its responsibility to collect or mirror all geo-data and products, it has recently entered into inter-agency discussions with Geoscience Australia with a view to safeguarding Australian geospatial data in digital form.

Research and copying services

The collection is housed in a single, central repository, at the National Library in Parkes Places by Lake Burley Griffin. The Maps Reading Room is located adjacent to stacks divided into post- and pre-1900 materials, the division allowing the rare maps an additional layer of security and supervision. The all-important map-user will receive a map minutes after making the request. There is a large reference collection, series indexes, gazetteers for most countries, and microform for property mapping in jurisdictions where originals are unattainable.

Concurrent with trends in data management and collecting of electronic map products, over the next few years as part of the Library's building master planning process, we will be examining the role of the Maps Reading Room in the context of other special materials delivery. This has been a recurrent theme among map libraries which have undergone restructuring and will provide a challenge for Maps at the National Library to redefine reading room service in the age of the digital map.

The Maps Reading Room has operated as a separate entity from 1968. It is staffed by the Maps team, with assistance from the cataloguers and other Library staff prepared to undertake client-focused training. The services include staffing the room (forty hours per week), responding to reference inquiries, and supplying image orders through a centralized "Copies Direct" system.

Over the past ten years usage of the Maps Reading Room and related onsite and offsite reference inquiries had been in decline. While user surveys continued to reveal a high level of user satisfaction, it was presumed that the reduction in inquiries was due to the rise of search engines and quantitative and qualitative improvements of online content. Interestingly, our most recent surveys indicate a resurgence in numbers of items requested, possibly linked to a surge in family history interest, and to publicity surrounding the recently published Maps book, *Australia in Maps: Great Maps in Australia's History from the National Library's Collection* (2008).

By contrast, demand for copying services has increased markedly. The proposition that an increase in

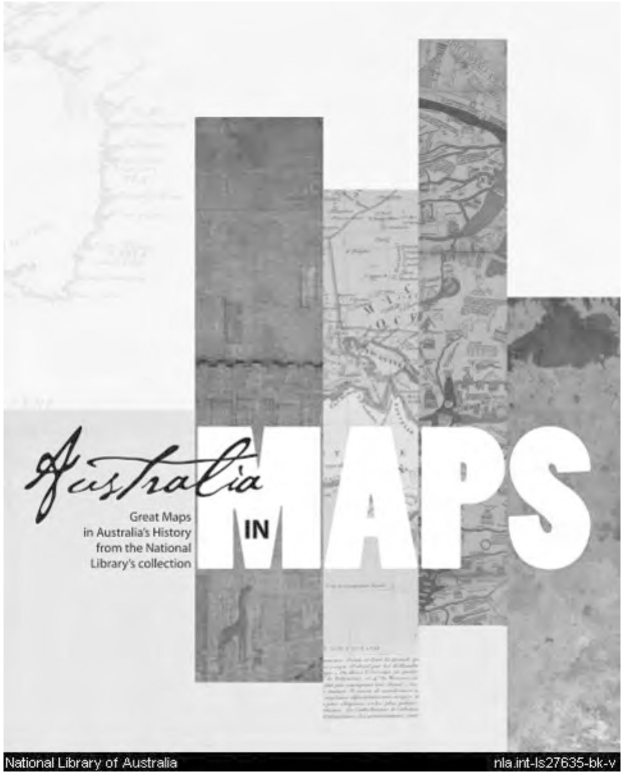


Figure 3. Cover from Australia in Maps: Great Maps in Australia's History from the National Library's Collection*, 2007. (see page 90 for color version)*

online content could potentially reduce staff-mediated inquiries does not appear to be supported. Over the past few years the volume of copying orders requesting maps via the Library's "Copies Direct" service have markedly increased, up 50 percent each year since 2005/6. The increase may be attributed to the addition of over 9,000 digital images of collection items since 2002 and discovery through Google and other Web search engines.

The acquisition in 2006 of a wide-format contact image scanner for archival scanning of cadastral plans and similar property mapping of interest to family historians has also been a contributing factor. The scanner addresses a preservation need– consistent retrieval of items, particularly for some regions nearer Canberra– and has had the effect of introducing more affordable high-resolution imagery, which users have been keen to accept. The scanner provides a high resolution color or grey-scale photocopies or digital files. The images created for clients are also uploaded to the catalogue through the Library's digital collection manager.

In June 2009, offsite requesting from the Maps collection was activated. The introduction of eCallslips for Maps allows users to track their own requests in the Library's catalogue, review their request history, and reserve maps at any time of the day or night. As eCallslips are generated from the online catalogue, difficulties associated with transcription errors and illegible handwriting are eliminated, while the system also provides improved security through matching user requests and items. Series maps presented the greatest challenge in implementing the eCallslips, with appropriate wording needed to instruct requesters to identify sheet numbers and/or names where there are no item-level records.

The challenge in coming years will be to be more outward looking–to participate actively in provision of cartographic resources, exploiting the potential of the historical collections through stronger ties with independent and university-based expertise.

Digitization

Digitization of collection materials has had a long genesis at the National Library. A 1999 pilot project to test standards for image capture of the pre-1900 Maps items was based on the Library of Congress rare map digitization project in 1996 and a presentation in Canberra the following year by the former chief of its Geography and Map Division, Ralph Ehrenberg. The National Library of Australia began two trial projects to determine the feasibility of scanning its own rare map collections.

The first project determined that direct scanning of originals with a digital (scanback) camera, rather than scanning of surrogates (such as photographic transparencies previously taken for conservation purposes) provided higher quality images. The second project established the technical requirements of such scanning. In 2001 the National Library embarked on a major expansion of its digitization program. The aim is to provide Library users with increased access to the special collections material through digital delivery. Each type of collection material has different requirements for digitization, as well as the management, storage, and delivery, and the Library developed a

Figure 4. Maps digitisation studio and vaccum board, October 2007.

digital collections manager (DCM) to manage this digital material.

The digital collections manager is used by Library staff and supports the digitization process, the creation of derivative objects for Web delivery (for example, low-resolution thumbnail and view copy JPEG images), and the storage of technical metadata and digital files. DCM currently supports management of images (including pictures, maps, books, sheet music, and manuscript materials) and is being enhanced to support management of audio recordings.

Maps chosen for digitization initially were from Petherick and other early maps collections. While out of copyright, the rare and often very fragile nature of parts of the collection has meant that access to the maps has been restricted to either onsite use or through photographic copies. This has been slow and restrictive for most users. It was anticipated that digitization would improve access for both Australian and overseas users, and it is interesting to see that over 15 percent of copying orders for maps come from overseas clients.

For map digitization, the Library uses a scanner back-mounted on a large-format studio camera. The system is installed on a high-precision, custom-built trolley, which moves backwards and forwards on specially laid tracks. With this device, it is possible to capture maps up to 100cm x 89cm in size (at 300 dpi resolution) producing 24-bit RGB TIFF, version six digital master files, up to 380 Mb in size. Larger maps need to be photographed in parts. For greater flexibility and to speed up the capturing process, the originals are positioned on a vertical vacuum board.

Users can identify maps by first searching the Library's online catalogue and, if the map is in digital form, by following a link to the maps delivery system provided through a highlighted URL address contained in the catalogue record. Users can also link to an "interactive map" which allows them to zoom in to any selected area to examine fine details and then pan or zoom out to surrounding areas of the map. The interactive map facility is provided using MrSID waveless image compression and LizardTech Express Server technology. All map images are named using a persistent identifier, used for both management of the digital map image and for citation and referencing purposes.

Considering the depth of the Library's Maps dollection, a unique opportunity arises to enrich the user experience through improved context. It is becoming clearer that increasing use is made of Maps catalogue data with other digital sources in "mash-ups," and our use of GIS in the Maps Library will be a prevailing theme over the next few years. In 2010 the Library will develop access to its comprehensive holdings of the one to a mile Army topographic map series using GIS. The project will test various approaches, including utilization of licensed software such as ArcIMS versus open-source methods such as MapServer.

"Maps of Australia" pilot geospatial search

For over twenty years, the Library has been recording latitude and longitude data in its cataloguing records, waiting for the technology to exploit the data. To date, few successful examples of MARC fielded data have led to an area of interest search of catalogue records. This is, in part, a function of the data itself, which in most real library settings can be variable or absent. In 2007 Maps began to develop an interface to test the viability of searching defined by geographic area.

This initiative is being developed with other Australian libraries and currently encompasses the catalogue records, images, and item locations for over 100,000 maps of Australia held in libraries. The basic functionality provides a polygon search to return records and images where available. The search uses map coordinates and other information included in the map catalogue records. Where only coordinates are present, on-the-fly reference is made to Geoscience Australia's place names database to establish the extent of the result set. In cases where there are no coordinates at all in the record, a simple algorithm is applied that compares map sheet size with the scale statement.

The "Maps of Australia" pilot dovetails with and may contribute elements to another prototype service being developed. A unified discovery service focused on items found in Australian collecting institutions is intended to replace multiple entry points and specialized functionality tailored to collection formats such as maps.

The design so far is based primarily on decisions made within the Library to allow rapid development of the prototype. Feedback, ideas for improvement,

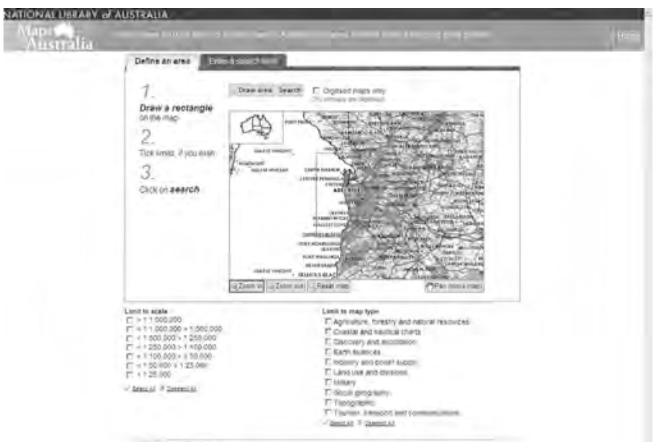


Figure 5. National Library "Maps of Australia" prototype search. *(see page 90 for color version)*

and input into the design of new features based on what is now available are invited.

References

South Land to New Holland: Dutch Charting of Australia 1606–1756, National and State Libraries Australasia (NSLA), formerly the Council of Australian State Libraries (CASL), *2006.*

Australia in maps: great maps in Australia's history from the National Library's collection. 2008. Canberra : National Library of Australia>

"Maps of Australia" prototype: http://mapsearch.nla.gov.au/

National Library of Australia Catalogue: www.nla.gov.au/catalogue/

Mapping: Methods & Tips

A Technique for Encoding Elevation Changes Along a Route

Daniel Huffman
University of Wisconsin at Madison

For many bicyclists and runners out in rugged areas, knowing the character of the route's terrain is critical: where the steep climbs, the downward slopes, and the flat stretches lie. Many bike maps, however, do not encode this information–they focus instead on showing the road network and which routes are safest for bicyclists. These are certainly important, but they do not help readers determine if they should press on to the next hill or stop and rest.

Proposed Symbology

The solution I propose is relatively simple: encode the elevation along the route using line width as shown by Figure 1.

Though simple, the symbology here is quite efficient. By varying the width of the line with elevation, this map allows the reader to access three data sets: the elevation of the path, the slope, and the aspect. When viewing the first variable, the reader's brain can derive the other two, by examining the spatial pattern of how elevation changes. The elevation itself is not particularly useful, but slope and aspect are critical pieces of information for the bicyclist or runner. Both need to be on the map together–knowing the slope of a hill is important, but users also have to know whether, as they head along the road, they'll be climbing up a particular steep slope or coasting down it.

So, the usefulness of the map relies on the reader's being able to determine how elevation is changing from one point on the route to another, in order for them to derive the slope and aspect. The symbology, then, needs to make this pattern of change as easy to understand as possible. Consider two different techniques for encoding elevation as shown in Figure 2.

The first encodes elevation along the path using color value and the other by varying line width, as I advocate. The slope of the route is much easier to figure out when line width changes than when the color value does. That the color at the left end of the line is lighter than the color at the right is relatively easy to determine. However, quantifying *how much* darker will be a challenge for the reader, when compared to the simpler task of quantifying how much wider the line is at one end than the other. Easy comparison of points is essential for understanding the change in elevation, and therefore the slope and aspect. Speed and simplicity of use is also important on account of the conditions under which such maps will be used. Some bicyclists do not even stop their bikes when reading maps, and so the map must work when they're not looking closely or long at it. Encoding elevation by line width has an additional advantage over any sort of color scheme: line widths are more robust–they won't vary according to lighting conditions as the readers travel in and out of shade of trees and in varying levels of cloud cover.

However, using color value does have two advantages of its own. The first is that by not changing line width, lines don't become too wide (causing crowding) or too narrow (and thus being hard to see). The second advantage is really more of a lack of a disadvantage–the highest elevations are not dominant. In Figure 1 the bottom half of the route stands out the most. Being at the highest elevation, it has the widest lines. But the route here also consists of largely flat stretches, which means that it's not a concern to bicyclists or runners–they want to know about the hills, about how the elevation changes. Encoding elevation

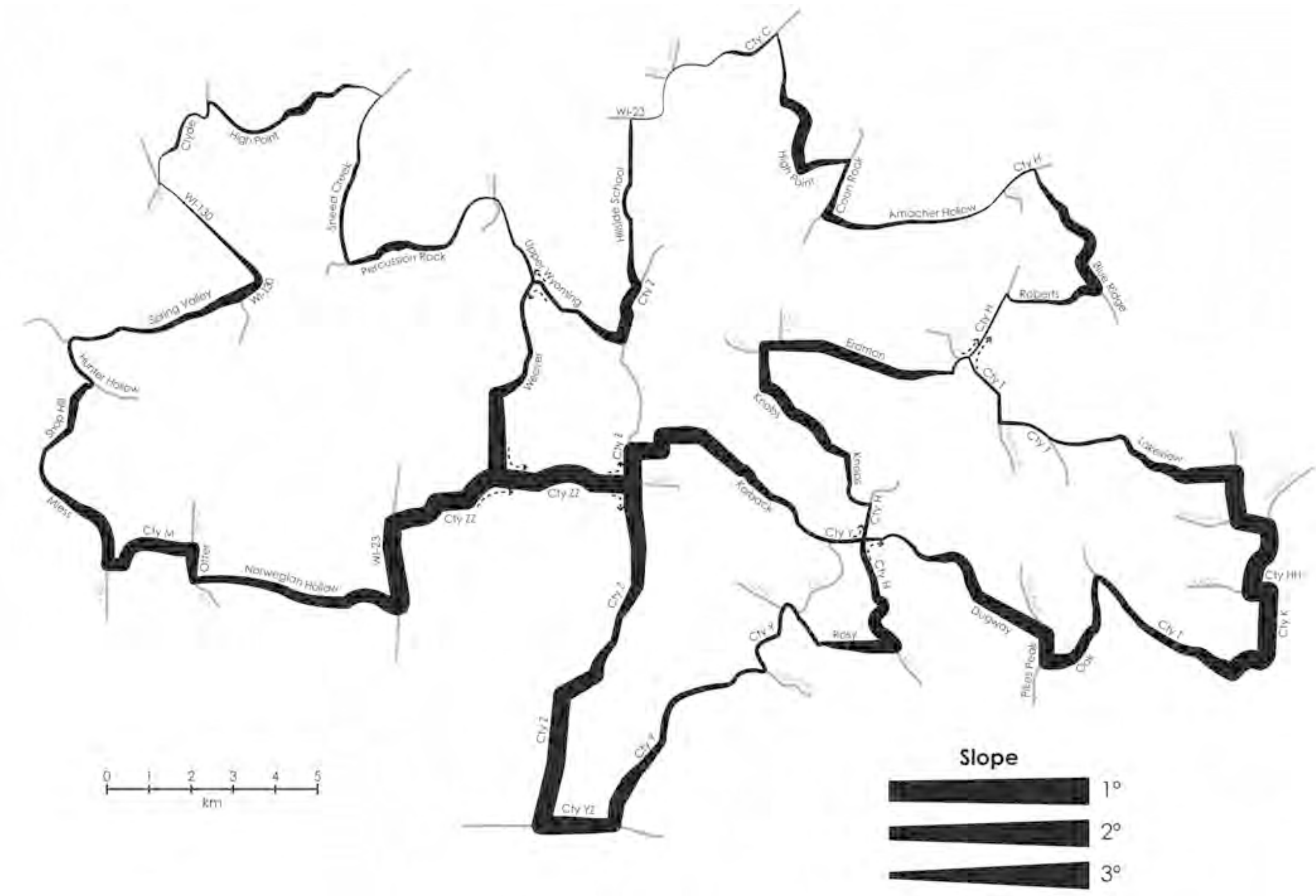


Figure 1. A sample map showing the proposed symbology.

by colors keeps the reader from being distracted as much by the high elevations, which will not stand out quite so much.

There is one further potential disadvantage to the proposed technique. Two equal slopes can look unequal, if they are at different elevations. Figure 3 shows two road stretches, each the same length, and each having the same change in elevation. One takes place at a lower elevation, however, and appears as though it is a steeper slope, when in fact the two are even, and are in fact drawn with the exact same line angles on the page.

Figure 2. Using a change in color value (top figure) and line thickness (lower figure). (see page 91 for color version)

Figure 3. Possible confusion over identifying changes in elevation.

Instead of encoding something the bicyclist is not interested in (elevation) and leaving it to their mind to derive the things they do want to know (slope and aspect), the latter could be encoded directly. Showing the slope is relatively simple, as it is a number. A color ramp or changing line width or other non-categorical symbolization will work for this. Aspect, however, poses a challenge, since it depends on which way the bicyclist is traveling down the road. It's uphill one way and downhill the other. A few possible solutions come to mind. Arrows could be drawn next to the route to indicate which way is uphill (or downhill). Color hue could be used for the route to show the aspect (red for north, blue for east, etc.), paired with changing value, saturation, or width for slope. A more interesting alternative is seen in Figure 4: using a pattern of chevrons or arrows to draw the route, each of which points downhill, and varying the size of those arrows or their lightness to show the degree of the slope.

There are more possibilities, obviously.

Figure 4. A possible symbolization method for showing aspect.

But these solutions have one significant weakness when compared to showing elevation directly–the reader has to process two different symbols (or two properties of the same symbol) and extract two pieces of information, rather than one. Most bicyclist and runner map readers intend to use the map to figure out the lay of the land,; they expecting to see something resembling terrain–hills, valleys, etc. Figure 4 above is too abstract-- it no longer feels like land, and so is harder to interpret. This is one reason why people like hill shading–mountains look like mountains, and that's something they can understand without a lot of mental processing. Experimental testing may show that it is possible that readers could eventually train themselves to interpret something like Figure 4 faster and easier than Figure 1, since it does show what they want to know and with the least amount of ink possible and without showing anything extraneous. But that will take effort and learning.

Production Technique

The linear symbols are built by determining the elevation of the route at several points and then connecting those points with line segments that increase or decrease in width according to the elevation at each endpoint, as in Figure 5.

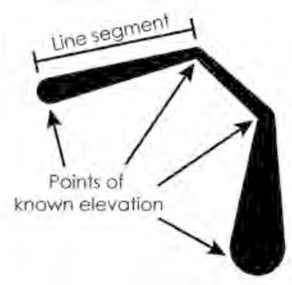


Figure 5. Showing the location of points of known elevation and line width changes in between.

The first step, then, is to create a set of points of known elevation. These points must be sufficient to roughly define the shape of the route and must adequately convey all major elevation changes. A good starting point for the latter is to use a GIS package to calculate the intersections between elevation contours and the users' chosen route. More points may need to be manually added to make sure the shape of the route is adequately conveyed as well, such as at road junctions and curved segments. Once the points are chosen, a circle is placed at each and scaled proportionally to the elevation. Figure 6 shows a field of points sufficient to create linear elevation symbols for the roads in an example area, each appropriately sized.

In order to create line segments that gradually and evenly change width, the project is next taken into Adobe Illustrator, where the Blend tool is used. This tool fills in the space between two objects with intermediate steps, to create a smooth transition, as in Figure 7. In this case, the intermediate circles are changing size to blend from one point of known elevation to another. Hundreds of steps in the transition may be needed in order to give the appearance of a solid line, as seen on the right-hand side of the figure. Blends can also be done along a curved path to help better represent the shape of the underlying road. Once the blend has been performed, the circles can be merged together into one simple, rounded line segment. The segments can them be joined into a complete route. The joints will be smooth and rounded, because the segments are based on circles.

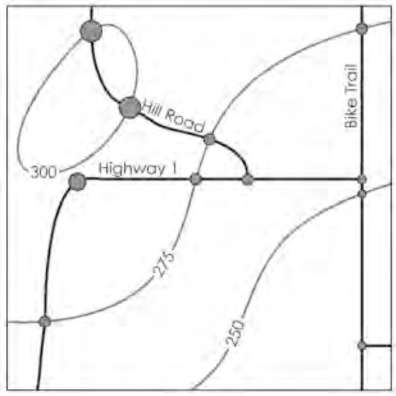


Figure 6. An example of a road network. (see page 91 for color version)

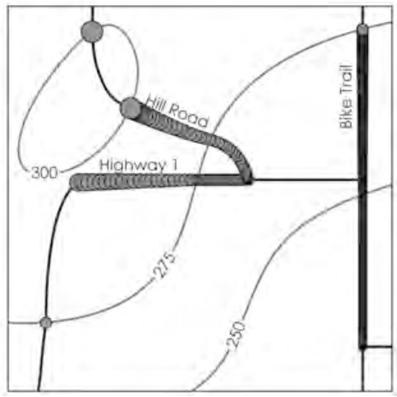


Figure 7. A sample of using the Blend tool in Adoble Illustrator. (see page 91 for color version)

The end result is a map in the style of Figure 1, in which the line width of routes varies according to elevation, offering map readers a simple way of understanding the terrain they will be facing on their journey.

An Alternate Production Technique

Worth noting is an alternate production technique developed by Jo Wood of City University London, who saw an earlier draft of this article published in an online blog. Mr. Wood begins with GPS tracks, recorded from previous rides along a route, as his starting data. He then runs them through a program written in Processing[1] to quickly generate a map based on this large set of input points. His technique has a couple of important advantages: it is much more automated than the one proposed above, and it generates a more complete terrain profile, being based on a larger set of elevation points than a manual selection technique. It does, however, require a prior trip along the route with a GPS unit.

Summary

Regardless of the technique used, the proposed symbology offers a simple and effective way to show map readers the character of the terrain they will be facing on a route by encoding elevation with line width. Readers can quickly understand changes in elevation and derive the slope and aspect information necessary to help them make decisions along the route. It is visually simpler than encoding slope and aspect directly and is not so abstract that it cannot be easily understood as representing a landscape. It is also compatible with current cycling maps–it still allows the depiction of road networks, which can be color-coded based on such things as traffic conditions or shoulder width. The technique simply uses up a portion of the "visual variable space" that is currently not being employed on most road maps. It offers a way for more–and highly useful – information to be added to route maps where terrain is important, to the benefit of bicyclists and runners.

[1]Processing is an open source programming language and environment for people who want to program images, animation, and interactions.

Visual Fields

Mollymaps started in my journal pages while studying abroad in central Asia. They were a way to recount a day's wanderings on foot. When I successfully got out of helping to write a group research project in exchange for drawing all the maps, I learned maps could be used as barter. I spent the entire year after college traveling around the world and, oddly enough, trading maps for room and board. Mollymaps has since developed into a small freelance business, celebrating the places that matter to people.

I still get nervous showing final products to clients—maybe because I am truly aiming to make the map that is in their heads, from their experience. And that's impossible, but I have to try anyway. When they look at the map, I want them to see their experiences. I want the map to be a place where a few shared memories can live. I don't always reach these goals but that is my aim.

I'll probably always make maps for whomever asks. But I'm a little tired of my 'happy pastures' maps—those that make landscapes look perfect, quaint and static. The hand-drawn message can do much more than appease our need for idyllic landscapes. Maps can draw attention to the tragedies and unsettling changes in our landscapes through the tragic beauty of irony, and the sobriety and sway of pen-to-paper expression. My project now is to take my skill set and apply it to environmental risks and injustices such as mountaintop removal, climate change vulnerabilities, point source pollution, irresponsible development; the list is rich with stories of real places and communities. Maps can draw us together to embrace or to revolt. All too quickly we are accepting the creation and use of slick, repeatable maps ("starbucks maps" as John Fels called them) and while they may be participatory, ubiquitous and novel, are they compelling? There will always be a need for the storyteller, reminding us again and again of the exacting beauties and tragedies of individual human experience.

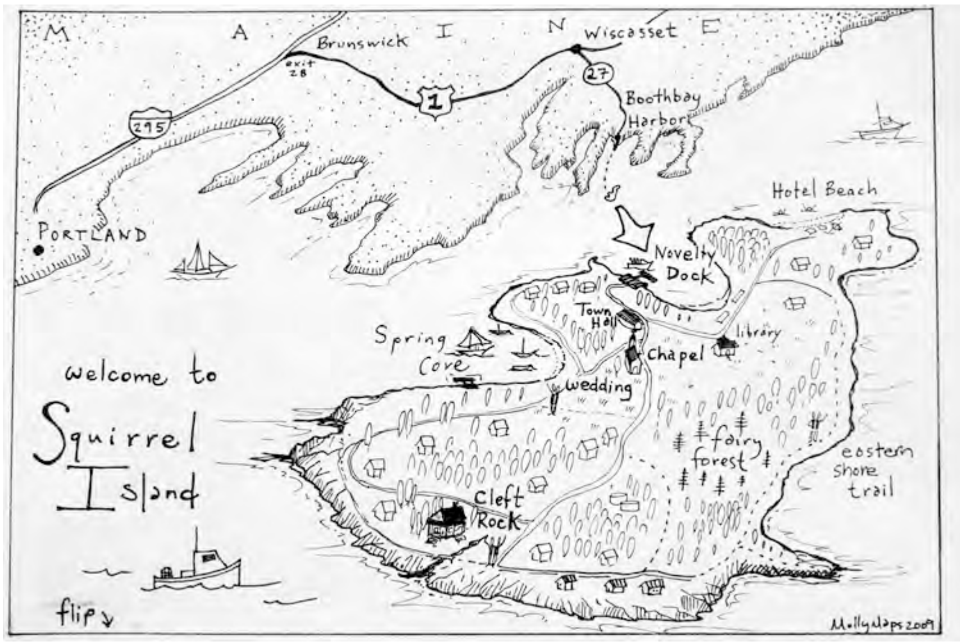
Molly Holmberg

For more information about Molly Holmgren's work, see www.mollymaps.com

The poster map for the Bangor Land Trust shows all of the parks and open space in the city in order to encourage people to get out and enjoy them. It took about three weeks to research all the parks on bike and foot.

Map of Llachon, a peninsula on Lake Titicaca, Peru. For two weeks I lived with a family who was building a small, community-based tourism business. I returned three years later to find a successful home-stay program and the original map still on the wall.

Map of generalized climate change predictions for New England based on analysis by the Union of Concerned Scientists. Developed for Artist As Citizen (artistascitizen.org).



One of several wedding maps I've done, this one was on Squirrel Island, off the coast of Maine.

Color Figures

Asymmetrical Learning of Locations on Maps: Implicit Learning, Prior Knowledge and Sex Differences

David K. Patton & Robert Earl Lloyd

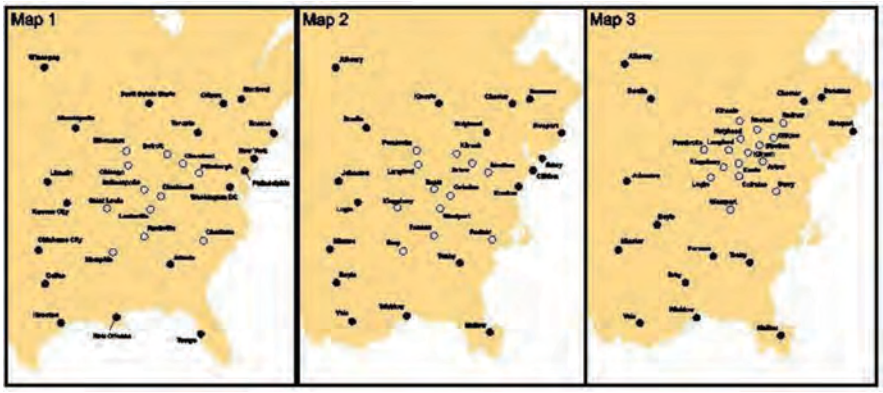


Figure 2. Map 1 represented a true background and true city locations and names. Map 2 represented a false background with true city locations and false names. Map 3 represented a false background with clustered city locations and false names.

The Maps Collection of the National Library of Australia

Dr. Martin P. Woods

Figure 1. Walter Burley Griffin (1876-1937). Canberra plan of city and environs, *part of* Eric Milton Nicholls special map collection, *1916.*

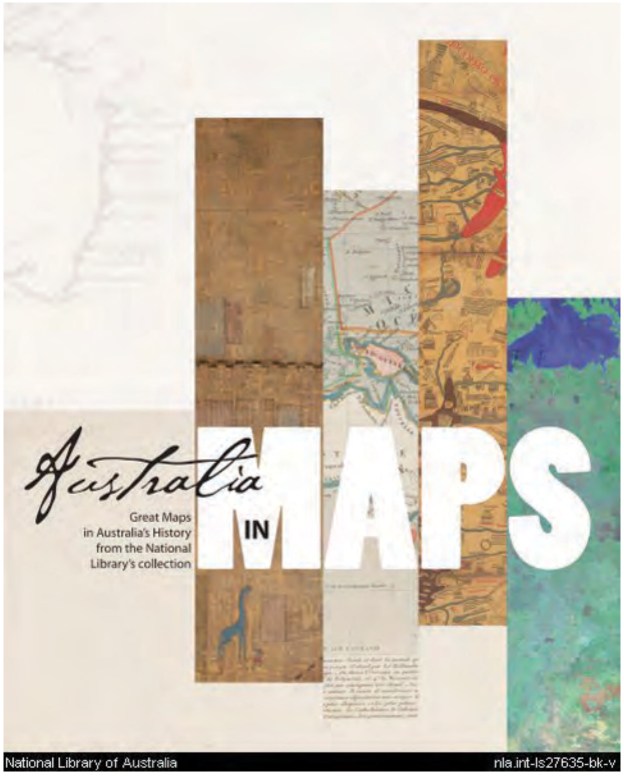


Figure 3. Cover from Australia in Maps: Great Maps in Australia's History from the National Library's Collection, *2007.*

Figure 5. National Library "Maps of Australia" prototype search.

A Technique for Encoding Elevation Changes Along a Route
Daniel Huffman

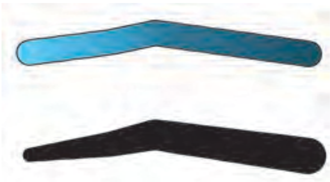


Figure 2. Using a change in color value (top figure) and line thickness (lower figure).

Figure 6. An example of a road network.

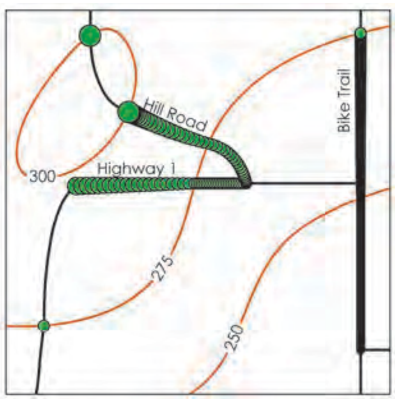


Figure 7. A sample of using the Blend tool in Adoble Illustrator.