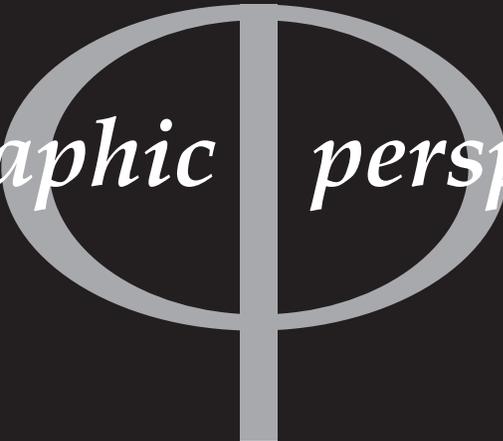




cartographic perspectives

journal of the
North American Cartographic Information Society

Number 49, Fall 2004



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Letter from the Editor

Dear Members of NACIS,

Welcome to CP49, the third and final issue of *Cartographic Perspectives* for 2004. In this issue the discussion of "Cartography is Dead" continues. James Carter from Illinois State University offers us the edict here that Cartography is Alive. Jim's piece provides us many examples of how cartography is still very relevant...it is a view that will resonate with many of CP's readership...but let's not lose site of some of the important points that Denis (and subsequently Tom Koch) made in their columns. Cartography is changing...rapidly...to think that I was doing production cartography in 1990, and now 15 years later, I concern myself (and students) with map animation, multimedia maps and virtual spatial representations. I would venture that cartography is not really dead...it is simply evolving. Getting a handle on this evolution is really what the opin-

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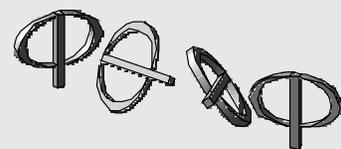
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about the cover



The cover image was created by Matt Knutzen, artist, cartographer and Assistant Chief Librarian of the Map Division of the New York Public Library.

(letter from editor continued)

ions from Wood, Koch and Carter are all about—at least, that is how I see it. To see the term Geo-visualization now in job postings for academic positions, in addition to, or in place of the term “cartography” is really a sign of this evolution. Add to this the use of the term “GIScience” in these job postings, we begin to get a sense of how cartography, or cartography like things are being talked about and categorized in the discipline. What do you think? Send your thoughts and opinions on to me.

In addition to being the third and final issue for 2004, this issue of *CP* ushers in a new section designed to showcase maps being made by cartographers today. The idea behind this section is to publish, in a one-page, informal style, maps that present to the reader, from an aesthetic standpoint, a really “awesome” looking map. These maps are accompanied by a short paragraph that describes the uniqueness of the map. The name for this new section is *Visual Fields*. Bob Lloyd, University of

South Carolina and member of *CP*'s Editorial Board, proposed this name several months ago, citing that it is a phrase that is “used in the cognition literature to indicate the area from which one can obtain visual information”. I think this title for this column is a perfect fit for what we are trying to accomplish with this new section. For this issue, two maps have been included: one from Mike Herman, and one from Alex Tait. I welcome your comments on this new addition to *CP*. I also welcome submissions of your visual fields.

The three papers included in this issue present to us a good example of the wide range of research that is taking place in cartography. The paper by Joshua Comenetz explores the use of visuals, or graphics to present metadata about maps, rather than text notes that are commonly used today. The paper by Leitner and Curtis presents a series of empirical studies that evaluate various methods for presenting confidential spatial data on maps. These methods attempt to maintain confidentiality, while at the same

time preserve the dominant characteristics of the spatial distribution. The third paper by Pearson provides a historical account of how topographic mapping in the Shenandoah Valley of Virginia was used during the Civil War in 1861-1862. It also provides a wonderful snapshot into the lives of four topographical engineers.

Lastly, I want to welcome Mike Herman to our editorial board. Mike resides at the University of Maine, Orono working in the Canadian-American Center where he is producing the Historical Atlas of Maine. Mike also runs a small map publishing company called Purple Lizard Publishing. Mike's knowledge and experience make him a perfect fit for the current cadre of editors I have on the board. I am delighted to have his expertise available to *CP*!

That about wraps up 2004. As always, I welcome your comments, suggestions, manuscripts, and opinions. Have a colorful Fall.

Warmest Wishes,

Scott Freundschuh, Editor

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Cartography is Alive (Thank God!)

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With the title *Cartography is Dead, (Thank God!)* Denis Wood certainly gets our attention (Wood, 2003). While he makes some interesting and relevant points much of what he proclaims misses the mark and does little to support the title. I proclaim that there was a misdiagnosis and that cartography is alive and well.

Wood equates cartography to map making and because he no longer sees a place for map design and production courses within the university, he states cartography is dead. I agree with his observation that many courses in map design and production have or will be phased out in the future and that few departments will replace their cartographers with someone in kind. But I see advanced graduates with solid training in cartography being hired and being in demand inside and outside academia. And, I see bachelor students who have completed courses in map design and production being hired because employers want their talents and skills.

Certainly, GIS in all of its dimensions is the technology of the moment and there is considerable demand to offer courses in this collection of technologies. In most university curricular processes courses can only be added by dropping other courses. So, it is not surprising that the more traditional techniques courses will be dropped for the more fashionable GIS courses. But cartography survives in part as a component of GIS for as Goodchild (2004, 301) noted: "As GIS has become more popular and widely adopted, more and more attention has been paid to its fundamentals, and there has been a resurgence of interest in such topics as cartography (and its generalization in GIS visualization), quantitative geography, and spatial statistics."

Cartography and GIS

While Goodchild considers cartography to be one of the fundamentals of GIS, Wood implies there is little role for cartography now because that functionality has been replaced by GIS. I was one of the early instructors in GIS and have watched cartography and GIS evolve. Cartography, maps and mapping are part of GIS, but only a part. While cartographers have much to contribute to GIS, many other disciplines do too because GIS is a convergence of many disciplines and technologies.

Two experiences come to mind to show a place for cartography in GIS. Years ago I managed a project to create a vegetation map of the Great Smoky Mountains National Park using classified Landsat data. When the lead researcher completed the classification for the entire Park I took the printed map to the plant ecologists for their first viewing. Their reaction was quite negative for they did not see the logic of the patterns on the map. As I watched their reaction I realized that the color scheme used on the map was not logical. I went back to the computer and generated a new color scheme using my experience as a cartographer. The ecologists immediately fell in love with the revised map because they could see the logic of the patterns. The only change to the map was my application of the cartographic touch in selecting better symbolization.

Recently I met with a group of colleagues to rank a number of sub-watersheds in a regional watershed. We were called upon to look at a number of variables presented to us on maps generated from a State of Illinois GIS system. On one map we questioned the patterns. I observed that all maps had been created using five classes broken into quantiles and that the top category grouped sub-watersheds of considerable differences. The operator of the GIS used the system to generate maps—period. When we looked at the numbers behind the maps we saw different patterns. As a cartographer I knew the processes of classifying data and it caught my attention. I had to explain the process to the others.

Ah, yes, the GIS technicians will make maps and will generate statistics and will classify remote sensing data. Gosh, if they can do this so easily why do we not get rid of statisticians and remote sensing specialists as well as the cartographers? Or, are those fundamental disciplines important in a GIS world? I think they are and cartography will continue to have an important niche in a GIS-dominated society.

Map Makers and Other Practitioners

In my thinking there are two foci, or communities, in GIS. One community is concerned with building and maintaining databases and using those databases for management and operations that have a spatial component to them. The other community is concerned with the development of a set of techniques to work with spatial data. With this concept of GIS I realized there are practitioners in many areas of study and analysis who perform tasks similar to those of the GIS world but who are not traditionally thought of as GIS workers. Included in these broad areas are the weather forecasting, marine exploration, navigation, and the petroleum exploration enterprises (Carter, 1989, 5). Since I first advanced this idea the GIS industry has made some expansion into these other areas of study and analysis.

When we look at these other areas we find many people making maps but they tend to do so outside of the traditional worlds of cartography and GIS. Consider the weather forecasting enterprise, which is charged to collect data from around the world, evaluate the data, aggregate it in central places, generate many maps and make forecasts, disseminate those maps and forecasts to regional and local persons who then create map presentations and announcements and get the word out to the public at large. All of this is done in near-real-time, 24/7. I argue that those many weather maps on television and in newspapers are the maps seen most often by the citizens of the world (Carter, 1998). Where are cartographers in this process? There are very few. The meteorologists have been able to create the concepts of weather and symbolize weather on maps at various levels of the atmosphere. They have created symbols to represent fronts and other weather phenomena and have done so without a cartographer present. In fact, Brewer (1997) recently observed that cartographers are now willing to accept color schemes used by the meteorologists.

The academic disciplines of geology, soil science and meteorology are heavy users of maps but I know of no cases where they have courses on how to make maps. Rather, they incorporate map making and map use into the content of many of their substantive courses. Map making and map use are inherent in any weather forecasting course. It is common in geology to have a multi-week field course incorporating geologic mapping. And, now, many students in geology and soil science are likely to take GIS instruction and as such probably get more exposure to cartography than they did before. Indeed, many people have been making maps

in their disciplines without much direct involvement in cartography for decades.

Professional Cartography and Map Making

In his first paragraph Wood states that "mapmaking is freeing itself from the dead hand of academia." He goes on to talk about our failed attempts to make mapmaking a profession. Then he looks at how many people attend an ESRI Users Conference compared to how many people attend a NACIS Conference. By golly, there are many people out there making maps and they do not call themselves cartographers or geographers. But, in my mind this does not demonstrate that 'Cartography is Dead.'

Two decades ago I was more active in ACSM and headed the Education Committee. In those roles I was concerned about setting standards and the direction of cartography as it jockeyed for its place in the mix of mapping sciences. GIS was emerging and I was part of that move, but I still thought of myself as a cartographer. Then a student asked me what he needed to do to become a cartographer. I responded ". . . all any student needs to do is get enough education and/or experience to think of himself or herself as a cartographer and then to convince others that he or she is qualified to be a cartographer. After all, that is the way the rest of us have become cartographers" (Carter, 1987, 23).

Indeed, I still feel this way, which seems to be consistent with Wood's arguments. I went on to consider what I expect in someone who I would be willing to call a professional cartographer. I contended that to be a professional cartographer one should have good working knowledge of: the use of maps; sources of maps and map information; interpretation of maps; construction of maps; production of maps; the issues of accessing, storage, and preservation of maps; and the institutions and literature related to cartography (ibid., 24).

I do not expect a professional cartographer to be a master of all of these topics, but each professional worthy of the title should know enough about each topic to know what they know and what they do not know. When a professional does not know something relevant to the profession, I expect that person to have an idea of where to go to get an answer.

What does it take to become a cartographer, professional or not? We are one of those professions which do not require specific credentials to bear the title 'professional'. In that regard we are similar to economists, historians, mathematicians, and philosophers. A few disciplines license some of their professionals, such as architects and engineers although there are many practitioners of these professions who are professionals but cannot use the title formally. In other cases, the state licenses practitioners, such as physicians, surveyors, cosmetologists and barbers. Some disciplines certify their practitioners, such as accountants, geologists, photogrammetrists, consulting meteorologists and television weathercasters. Two decades ago I considered the benefits of a formal certification program for cartographers but for many reasons concluded it was not worth the effort (Carter, 1985). Some academic GIS programs are now certifying their students so that they appear to have met some standard. As a cartographer I am content to be in the same camp with the economists, historians, mathematicians and philosophers than with the physicians, surveyors, barbers and cosmetologists.

Just because one does not have to take one or more specific courses in cartography to become a cartographer does not mean there should be no courses in cartography. I note that my University has courses in creative

writing, legal writing and technical writing but I know that great numbers persons are successful writers who have never had such courses. And, I am certain some persons who have completed these courses write some real garbage. So, completing a writing course is neither a prerequisite to, nor a guarantee of, becoming a writer. The story is similar for other creative activities such as acting and performance.

Wood notes that many people who were not trained in cartography courses in geography departments have made contributions to cartography or have produced significant maps. So, what else is new and how does this make us any different from other fields of study? I think back to my undergraduate days when I took a course under Dr. Kenneth P. Williams, the award winning author of the multiple-volume series *Lincoln Finds a General*. Dr. Williams was my calculus professor. I am certain many historians were envious that a mathematician wrote more award winning history than they did. And, there are many successful business leaders and politicians who did not study economics, management or political science but they are very good at practicing economics, management and politics.

Wood not only gloats that non-cartographers make significant maps, he also contends our profession has no power. Wood looks at the case of the opposition to the Peters map and the great effort to ban rectangular map projections of the world. He states that the resolution we circulated (which I probably signed) "had no effect—its laughable lack of effect—demonstrated to one and all how little authority the profession had" (Wood, 2003, 6). Gosh, that is news to me. While watching news or looking at press briefings on television I frequently reflect back that a few years ago the background map in these environments was the Mercator projection. Today, I seldom see the Mercator projection at those public sites. I have always thought we had some impact.

Our Birthrights to Maps and Mapping

I think Wood makes an interesting observation when he says we have a birthright to make maps... "when it comes to mapmaking there are no outsiders, no more than there are outsiders when it comes to speaking or writing English. These are birthrights of the members of our society, who acquire the ability to speak and make maps as they grow up in it. Speaking and mapmaking are not like open-heart surgery or professional basketball, which do require specialized training and years of practice. You can't just step into the shoes of an NBA player and expect to score. You can't just claw your way into your friend's chest and repair her heart no matter how insistently her situation calls for it. But when a communication situation calls for speaking or making a map, you can just open your mouth (or attack the keyboard) or pick up your pen (or your mouse)" Wood, 2003, 6).

While I agree with some of the above, I would like to rewrite it as: Everyone has a birthright to think for himself or herself and participate in those activities that appeal to them, with some constraints. As such we should be able to speak, write and make maps. And, we should be able to select our own diets and medications and we have an obligation to look out for the healthfulness of our loved ones and the environment around us. And, we can play and participate in individual and organized sports, be that walking, golf or basketball. Great numbers of people function well in society by speaking up, taking care of their own health, making maps and playing sports. We acknowledge that some people excel in one or more of these practices. When we look at who excels we find that the prac-

tioners have some innate talent, have dedicated themselves to the task and have put in a lot of work and practice to hone their skills.

Many thoughts flit through my mind when I think further on his statement about speaking, map making, NBA basketball and heart surgery. While everyone can speak, many people want to improve on their speaking abilities and thus we find organizations like Toastmasters International, whose mission states: "Through its member Clubs, Toastmasters International helps men and women learn the arts of speaking, listening and thinking—vital skills that promote self-actualization, enhance leadership, foster human understanding, and contribute to the betterment of mankind" (Toastmasters, 2004). So, if those choosing to exercise their birthright to speak feel the need to gather together to help themselves be better speakers, I propose that we facilitate the formation of "Toastmappers", where everyone who wants to make and use more effective maps will gather together weekly to help each other to "foster human understanding, and contribute to the betterment of mankind" (ibid.).

How much experience and training does it take to become an NBA star? We don't know how young stars could be because they are not allowed to be drafted into the NBA until they graduate from high school. And years of experience do not count as much as size, speed, coordination and the ability of the body to take the wear and tear of this physical sport.

There are many alternatives in the practice of medicine but I will concede that only those with requisite training can practice open-heart surgery. But then I think of an uncle who at 88 was talked into by-pass surgery against the advice of his regular physician and family. He never regained consciousness and died six weeks after the operation. I suspect the surgeon took him apart and put him back together by the book but the end result was not effective. As I write this, there are news reports about surgical teams being forced to implement procedures to make certain the operations are performed as designed. It seems that too often surgeons cut off the wrong limb or operate on the wrong person. Although the patients might not appreciate it, those surgeons are licensed professionals.

Concluding Comments

I see a surgery analogy in the Denis Wood essay—he has attempted to operate on the discipline of cartography by slicing and dicing the organism into little pieces, but he did not try to put it back together. If we were a licensed profession we could refer his essay to a review committee to consider disciplinary action against the author. Instead we can ignore what he said, argue with him, or mull over his words to separate the insightful from the misguided. The choice is ours.

I am concerned that this debate will be taken outside the realm of cartography. I hope administrators who are looking for a place to cut to save money or to promote another program do not see this title because it is my contention that it is not appropriate and should not have been used. And, many of those administrators might never go beyond the title.

There is some food for thought in some of what Wood has to say, scattered among reckless and accusatory charges. His foundation for this essay is that courses in cartography exist only to teach people how to make maps for the rest of the world who cannot make maps. I hope I have been able to counter that argument for a more positive and useful perspective on our profession. I am still proud to call myself a cartographer.

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I want to thank Dr. Judy Olson for reading and commenting on a draft of this column.

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Visualizing Metadata: Design Principles for Thematic Maps

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This paper argues that the best way to transmit metadata to thematic map users is through cartography rather than text notes or digital means. Indicators such as reliability diagrams, common on maps derived from air photos or satellite images, are rarely included on thematic maps based on the census or other socioeconomic data sources. These data not only suffer from an array of quality problems but also are widely distributed among the general public in cartographic format. Metadata diagrams for thematic maps based on human variables therefore must be clear and concise, so as to be comprehensible by the non-specialist. Principles of good metadata diagram creation are proposed, with attention to the balance between clarity and space constraints.

Key words: data quality, reliability diagram, thematic map, visualization

METADATA DISPLAY

Metadata should be included on thematic maps for the same reasons they appear on maps of topography or geology: to help users evaluate data quality, ascertain whether maps are appropriate for their intended use, and compare them with other maps. Among the most common ways to provide metadata are through text notes or metadata files, but when a map is based on data that vary spatially in quality or source, cartography is an efficient means of transmitting them. Previous research and published maps indicate that cartographers have essentially four options for the graphic display of metadata (Beard *et al.* 1994; MacEachren 1992; McGranaghan 1993; van der Wel *et al.* 1994). They may be displayed by means of:

- (1) A visualization technique on the main map (metadata overlaying main map)
- (2) A visual variable on the main map (enhancing existing map layer)
- (3) Animation or other computer-based technique
- (4) A separate map, often an inset map

Option 1 is frequently employed to illustrate basic data limitations. It has received relatively little attention from researchers, probably due to the limitations imposed by multivariate cartography. If display of metadata requires use of an additional visualization technique, then it will confuse those users who are unused to maps composed of multiple layers. The best-known example of this kind of metadata indicator is the use of the color purple by the US Geological Survey to indicate revisions on the 1:24,000 series of topographic maps. This is effective because that color is employed solely for updates and communicates only a single dichotomous item of metadata (whether or not an area has been updated). The

same principle underlies the use of blank space to inform users that data were unavailable or fell below a minimum threshold for a given area, as in Brewer and Suchan's (2001) maps of racial and ethnic group distribution.

Pickle *et al.* (1996) employed a separate cartographic technique to map data availability. In a series of choropleth maps of disease-specific death rates by health service areas, they indicated "sparse data" by means of double hatching. This consists of "parallel white and black hatch lines [which] allow visibility of the hatching over light and dark colors." The choropleth colors are sufficiently distinct and the hatched lines narrow enough that one can easily perceive both layers (data and metadata). Numerous methods were considered during production of this atlas before selection of the hatching technique, including gray scales, textures, dots, and point symbols such as asterisks (MacEachren and Brewer, 1995). Hatching is effective as an indicator of the existence of a quality problem (e.g. sparse data), but would be less practical for more complex problems, as the use of multiple widths or colors of hatching would confuse the main map.

Previous research has focused on option 2. Maps constructed in this way do not need to have multiple layers, though they will be multivariate. Instead, existing symbols or techniques are enhanced by the use of an additional visual variable. As shown by examples in Edwards and Nelson (2001), metadata added through symbol enhancement have the virtue of not adding additional objects to the map. For example, if the size of graduated circles are used to represent data values, one may add metadata by coloring the circles. The problem with this method is that it may be impossible to add metadata to all parts of the map. It is difficult for users to determine the color of very small graduated circles and therefore metadata will only be transmissible for those regions whose circles are above a size threshold. A similar problem hinders the use of the third dimension to indicate data quality. Because taller prisms may obscure shorter ones, "several views may be required to gain a complete picture of the data" (Beard and Mackaness 1993). This is practical online but not on paper where space is at a premium.

MacEachren (1992) proposes communicating the uncertainty level of data through direct manipulation of map objects. If data values are uncertain or the limits of regions undefined, this lack of certainty can be communicated by making map objects and symbols "fuzzy" or adding "fog" to the map, *i.e.* eliminating or reducing the sharpness of edges and instead using color gradations to indicate regions, boundaries, or attribute values in dispute. One limitation of this method is that it is itself uncertain: users have no means for quantifying the degree of uncertainty displayed (a difficulty previously encountered in studies of continuously-variable gray shading for choropleth maps). Nor is it always possible for cartographers to quantify a single variable called "uncertainty". Use of different or multiple cartographic techniques for display of fuzzy data (Plewe 1997) may mitigate this problem, but, on a more basic level, people without cartographic training (most people) may interpret foggy images as publication errors rather than intentional features of a map.

Another potential problem for maps intended for wide dissemination is that some users may be confused by the addition of metadata to a map. According to one study, the level of confusion is highest with non-graphic metadata indicators (*i.e.*, notes in text format) (Edwards and Nelson 2001). However, this difficulty has not been fully quantified by studies of cartographic perception, in part because study subjects are often students in geography classes—a group that by definition has a higher level of interest in and knowledge of maps than the general public.

"... on a more basic level, people without cartographic training (most people) may interpret foggy images as publication errors rather than intentional features of a map."

“Even on the internet, most maps are essentially digital equivalents of paper maps. Thus if one is to transmit metadata to all users in an easily-accessible format, it is still necessary to think in terms of static (whether paper or digital) rather than dynamic display of information.”

As cartography has become a digital endeavor, new methods (Option 3) for display of metadata have been developed. Van der Wel *et al.* (1994) review an array of techniques involving time, sound, and computer graphic effects. Perhaps the most intriguing animation technique is described by Fisher (1993). In his “error animation” technique, pixels flicker between possible alternate attribute values with each value being present with a relative frequency equivalent to its probability of actually occurring at any given point, thus avoiding the use of mixed or gradational symbols. In a similar vein, Evans (1997) produced a map in which a reliability layer flickered over a land use layer. Veregin (1993) and Fisher (1994) employed sound to transmit quality information, using a variety of audible signals to indicate the existence of different quality problems and the level of reliability of the source data. Though these methods allow for simultaneous communication of data and metadata, the majority of thematic cartography continues to be directed toward paper publication. Even on the internet, most maps are essentially digital equivalents of paper maps². Thus if one is to transmit metadata to all users in an easily-accessible format, it is still necessary to think in terms of static (whether paper or digital) rather than dynamic display of information.

Certain types of inset maps (Option 4) are widespread. These are often called reliability diagrams because they are intended to help users assess aspects of data quality. While they have been in use for more than 50 years, in the vast majority of cases they have been applied only to maps based on airphotos or satellite images. Reliability diagrams commonly indicate the scale, resolution, or date of acquisition of source images or maps, or the revision date (Figure 1). Yet as Wright (1942) noted, the “basic reliability” of government topographic maps is hardly in doubt, but one cannot “take on faith the reliability of the average . . . statistical map.” Why, then, are metadata indicators so common on the former and absent from the latter?

A literature review revealed only one example of a demographic map with reliability diagrams. Porter (1956) conducted a census of Liberia, using airphotos to count housing units. After estimating the number of people per housing unit for different regions of the country, he was able to obtain an estimate of the total population of Liberia. He created a detailed population map, on which he included two inset maps (Figure 2). The first rates the accuracy of the housing unit counts while the second evaluates the probable error in the estimates of people per housing unit. The first is

“A literature review revealed only one example of a demographic map with reliability diagrams.”

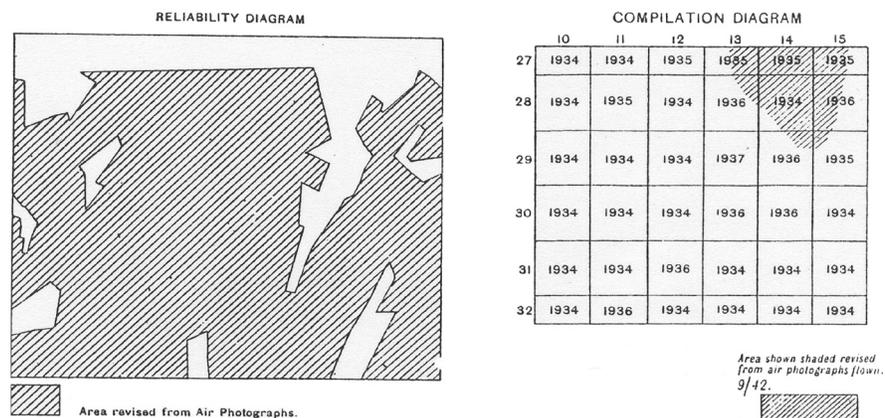


Figure 1. Sample reliability diagrams from topographic maps. Diagram on left from Ordnance Survey (1943) indicates revised areas with hatching. Diagram on right from Ordnance Survey (1944) also provides dates of compilation.

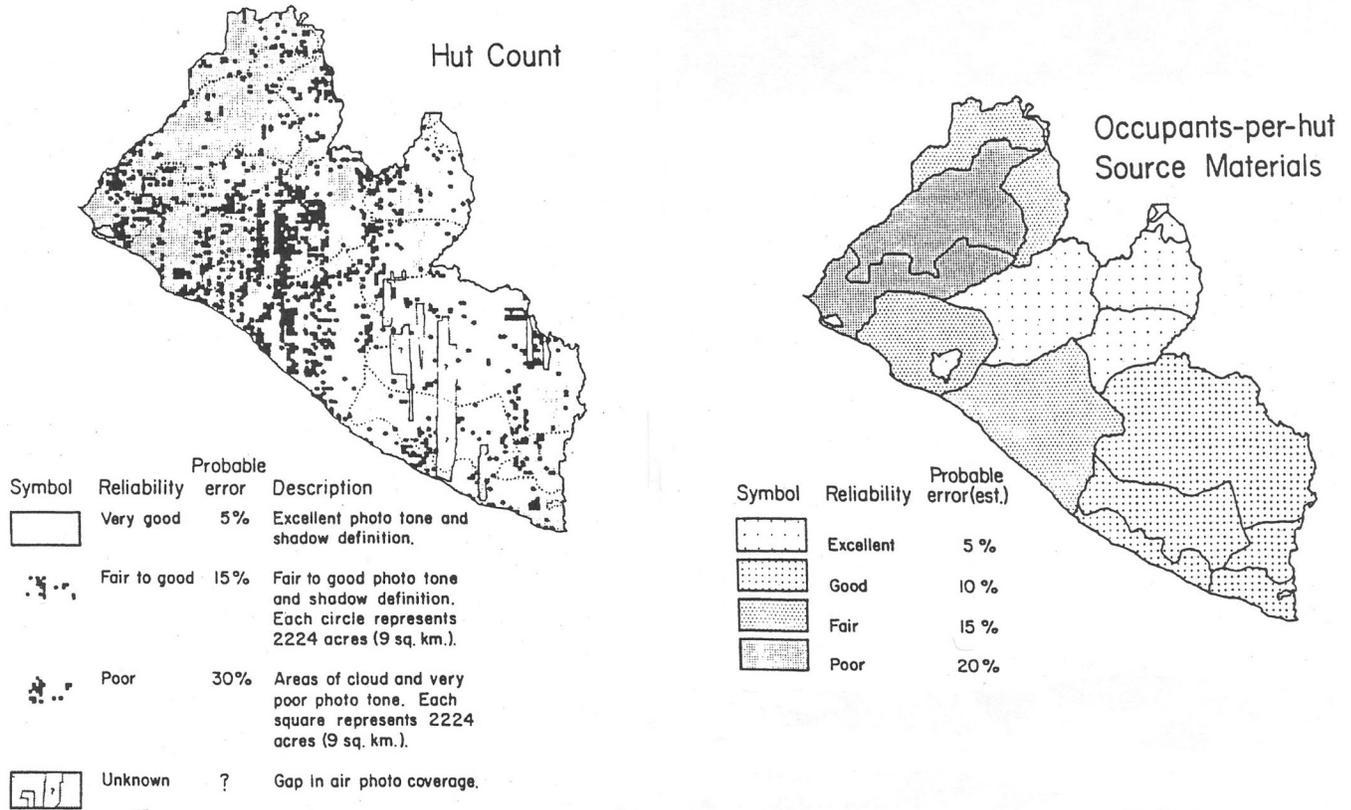


Figure 2. Reliability diagrams from map of the population of Liberia (Porter 1956). Diagram on left assesses quality of source data (airphotos). Diagram on right evaluates quality of demographic information (persons per housing unit).

particularly useful to map users because it indicates the quality of the airphotos—based on clarity and the level of cloud cover—used as data sources and shows areas where no airphotos were available.

The advantage of inset maps is that they are separate from the main map layer, without consuming precious space¹. Within space constraints, inset maps can be made as complex as needed without risk of visual conflict with the primary map layer. At the same time, as McGranaghan (1993) observes, separation from the main map also introduces the primary deficiency of inset maps or reliability diagrams: they must be “mentally overlaid” on the main map to be properly interpreted. When the main map is a topographic or geological map and the reliability diagram shows information about airphoto or survey coverage, this will be difficult because coverage zones of data sources do not correspond to mapped areal units. The edges of a survey or photo do not follow contour lines or lithologic contacts, making it difficult to match regions and boundaries depicted in the reliability diagram with those shown on the main map. Thus if one is to argue in favor of inset maps in preference to the other options, it must be with the proviso that insets are to be designed so as to ease mental overlay. This can be accomplished with socioeconomic data because data and metadata are reported for the same areal units, or for units at different levels in a standard hierarchy. For example, if the main map shows data for counties, metadata may be available for counties or states. If one includes state boundaries on the main map, users will have no trouble comparing state-level metadata with a main map based on counties.

“The advantage of inset maps is that they are separate from the main map layer, without consuming precious space. Within space constraints, inset maps can be made as complex as needed without risk of visual conflict with the primary map layer.”

METADATA AND DATA QUALITY

The term "reliability diagram" implies the transmission of information about data quality. Inset maps can, however, display geographic variation in any data that describe the source data, whether or not related to quality. Therefore the term "metadata diagram" is more appropriate, because metadata include all information about data (or data about data) that users need to fully understand the data, e.g. sources and processing methods. Inset maps will be most appropriate whenever metadata should be displayed spatially but need not appear at the same scale as the main map, that is, in situations where the metadata are neither very basic nor very complex. In the former case, a text note or visualization technique (Option 1 above) is sufficient, while the latter case calls for an independent, full-size metadata map (see Note 1).

"Inset maps will be most appropriate whenever metadata should be displayed spatially but need not appear at the same scale as the main map, that is, in situations where the metadata are neither very basic nor very complex."

In principle, there is no reason why metadata diagrams should be limited to source and revision information on image-based maps. Many types of thematic map are based on multiple data sources, or on data of different vintages. One cannot, for example, create an international demographic map without recourse to multiple data sources. Even the uniform data publications of international agencies depend on reports from national statistical agencies. These in turn depend on census and survey results obtained at different points in time in each country, by different methods. Date of acquisition and revision information should be shown on demographic maps where possible to allow users to assess reliability or fitness for use. But these are not the only items of metadata that may be of interest to map users. Definitions of mapped variables (e.g. ethnic groups or the poverty level) may differ among sources, errors may be introduced through the cartographic method, and accuracy can vary widely even within a single data set. While a satellite sensor will have a fixed pixel size, resolution, and bandwidth, the same is not true for the human equivalent, the census form. The level of undercount in the census is not uniform across the US, despite the use of a uniform survey instrument. If users can be informed of geographic variation in these metadata by cartographic methods that do not detract from the main map, they will surely be able to make better informed choices about reliability and fitness for use.

"If users can be informed of geographic variation in these metadata by cartographic methods that do not detract from the main map, they will surely be able to make better informed choices about reliability and fitness for use."

One reason for the scarcity of metadata indicators on demographic maps is the absence of published frameworks of data quality attuned to the needs of socioeconomic data producers and users. Though data quality is discussed in Census Bureau reports and demographic reference publications (e.g. Shryock and Siegel 1971), the demography literature does not include anything comparable to the discussions of the elements of data quality found in Bутtenfield and Beard (1994), Godwin (1997), and Gupta and Morrison (1995). These frameworks are perhaps too comprehensive for socioeconomic data. Many of their elements, in particular those directed towards positional accuracy and resolution, are of lesser interest for thematic mapping of demographic variables because they were clearly derived with topographic or image mapping in mind. Human data suffer from an array of problems related to semantics and human error that do not arise in endeavors of physical science. For example, while physical geographers and geologists may argue over the specification of soil types, it is at least possible to arrive at common definitions after discussion. In contrast, it is impossible to create a rigorous definition of a religious or ethnic group that will be accepted by all, because there is no scientific basis for such delineation³.

METADATA DIAGRAM DESIGN

To achieve its purpose, a metadata diagram must communicate information about data (1) rapidly and (2) without confusion to (3) all users, regardless of background in cartography. Cartographers do not have the luxury of designing graphics solely for their colleagues, as is the case in some fields: a good map can be used and enjoyed by experts and the general public alike. A metadata diagram must therefore be (1) graphically simple, (2) easy to understand, and (3) without jargon. Because a diagram will always be smaller than the map it enhances, simplification is essential. This means eliminating every unnecessary detail or graphic element: as Tufte (1983, p. 51) suggests, "Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space." All maps must be understood if they are to communicate information, but clarity is of even greater importance when designing metadata diagrams. Rapid comprehension implies the use of simple techniques, colors, and patterns; concise text; and omission of all extraneous detail. Successful communication with all users necessitates use of a simple vocabulary, omitting technical terms relating to data quality elements.

Though these may sound like good guidelines for all mapmaking, the fact is that many demographic maps have a high level of geographic detail and/or are graphically complex. While good design can compensate for the complexity of source data, this option is not available for metadata diagrams because of the time constraint of the map reader's attention span. One hopes that the user will, on viewing a complex but interesting map, devote extra time to understanding it. On the other hand, the user is likely to ignore a complex reliability diagram because it is not the center of attention: it is part of the "ground" rather than the "figure". This is all the more likely with thematic maps created for distribution to the general public, as opposed to topographic or geological maps whose audience is largely composed of people with a higher level of cartographic literacy. As with source notes, subtitles, and scale bars, a metadata diagram should not detract from the main message of a map but rather provide information to those who seek it. If readers skip over wordy titles or metadata notes, they will certainly pass over a dense graphic whose purpose is not clear at a glance. Thus the first priority in the design of metadata diagrams must be simplicity, followed by care in designing graphics and text that will be readily understood by a broadest audience.

Diagram Components

In the interest of conciseness, a metadata diagram should have a minimum of separate graphic elements. As the main map layout will already include a title, the author's name, a north arrow, etc., these can be omitted from the diagram. A scalebar is also unnecessary because it should be obvious that the diagram covers the same area as the main map, and scale is not relevant to the message of the diagram. There are at most two essential elements: the diagram itself and a legend describing the symbols, colors, or patterns used in the diagram. The title of the legend can substitute for a larger map title (as in Figures 3 and 4b). Symbology should be kept as simple as possible; choropleth shading or line patterns (as in Figures 1, 3 and 4a) will work best in many cases. Point symbols (graduated symbols, shapes) may also be effective but only in cases where the areal units in the metadata diagram are relatively few. Otherwise there is the risk of overlap, illegibility due to reduced size, or confusion from the clustering

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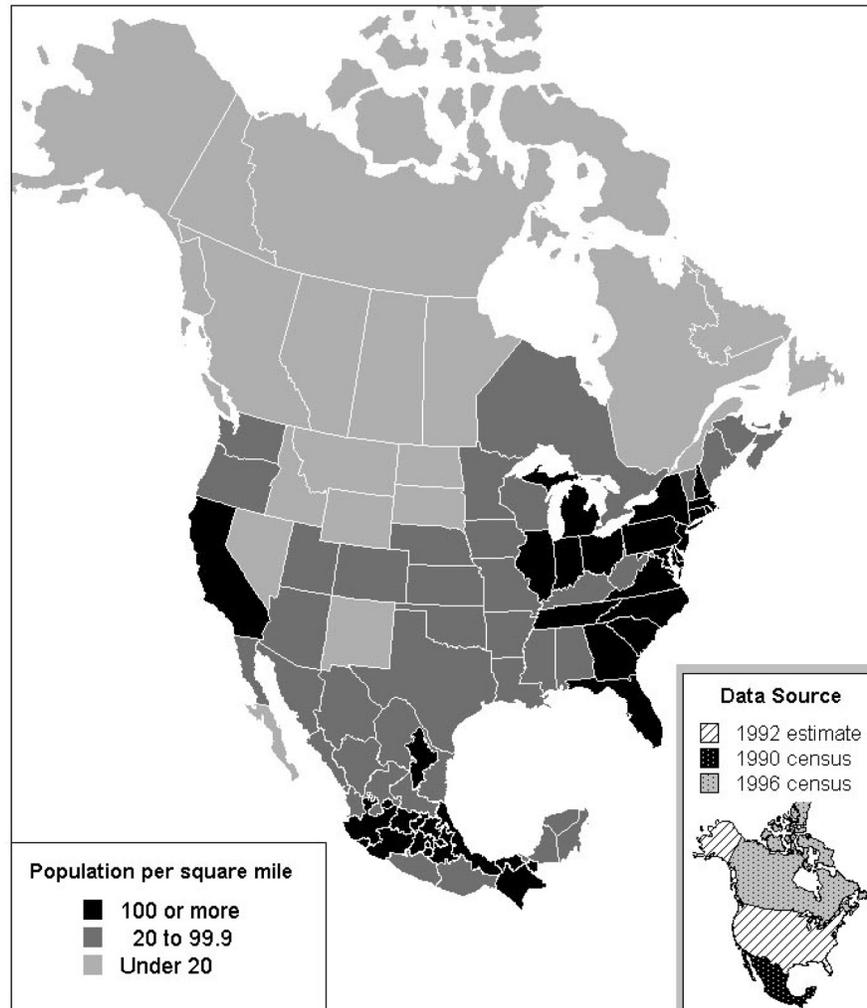


Figure 3. Population density by state or province in the USA, Canada, and Mexico. Metadata diagram showing data source and date.

“Where the diagram need only transmit a handful of items of information, such as a few dates or quality ratings, one may even omit the legend completely and print the information within the map units—hardly a recommended practice in standard cartography, but useful when space is at a premium . . .”

of many different objects in a small space. Where the diagram need only transmit a handful of items of information, such as a few dates or quality ratings, one may even omit the legend completely and print the information within the map units (Figure 5)—hardly a recommended practice in standard cartography, but useful when space is at a premium and one is not striving to communicate detailed patterns.

EXAMPLES

Figure 3 is a map of population density by state or province in the United States, Canada, and Mexico. Data quality is an issue because the data were gathered at different dates, and the population figures for Canada and Mexico are from censuses while the US data are estimates. The metadata diagram can, however, be greatly simplified and reduced in size relative to the main map because all data within each country were gathered at the same time and none of the three countries is very small relative to the others. Thus it is only necessary to show four areal units in the inset (continental US, Alaska, Canada, Mexico). The resulting diagram indicates both the date and method of data acquisition while occupying only a small fraction of the map area.

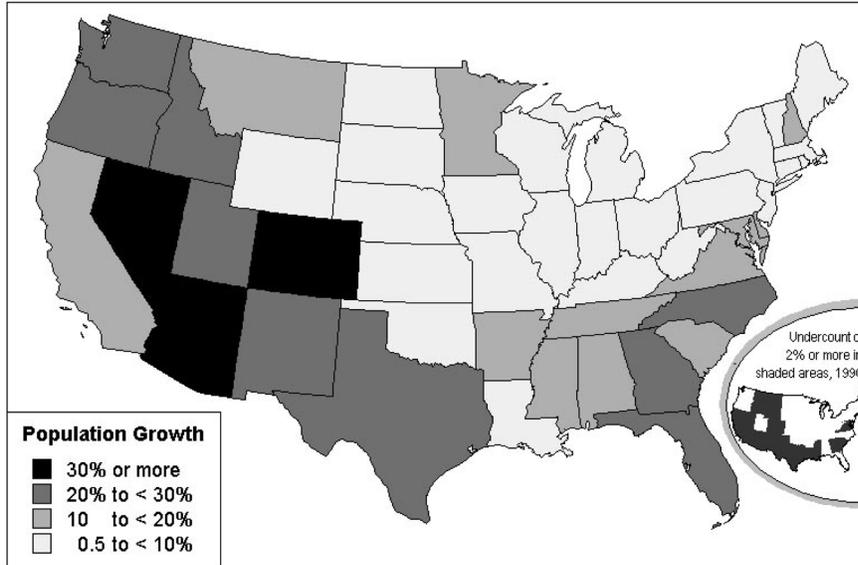


Figure 4a. Population growth from 1990 to 2000. Metadata diagram indicating undercount estimates for 1990.

Census undercount information can easily be added to a population map with a metadata diagram. Figure 4a shows the percent change in the US population from 1990 to 2000. The estimated net undercount in 1990 is shown in the inset map. In this case, the geographical units (states) are the same, but the reliability diagram uses a reduced number of numerical classes to ensure that it is still readable with a size reduction. State boundary lines are also eliminated to create a dasymetric image. Figure 4b is a less-simplified alternative version of the same diagram. Note that there is a correlation between states with higher undercount rates and states with higher population growth rates. This may in part reflect the reduction in the net undercount rate between 1990 and 2000. High growth rates from 1990 to 2000 are due not only to actual growth during the decade but also a fuller counting of people already present in 1990. Here, the metadata diagram does more than serve as an indicator of data reliability: it also enriches the message of the main map.

A metadata diagram can also provide information that helps the user interpret the main map, as opposed to assessing its accuracy. This stretches the definition of metadata, as it does not involve information “about” the data on the main map but rather adds to the user’s understanding of the spatial pattern revealed by mapping the data. However, the provision of this additional information has the same goal as the provision of orthodox metadata: to further inform the user about the data. In Figure 5, the main map shows the starting salary for teachers by township in a hypothetical region, while the metadata diagram shows the cost of living index by county (the smallest unit for which cost of living data are generally available). Users can readily observe where salaries have not kept pace with cost of living. County boundaries are indicated by heavy lines in the main map to reduce or elimi-

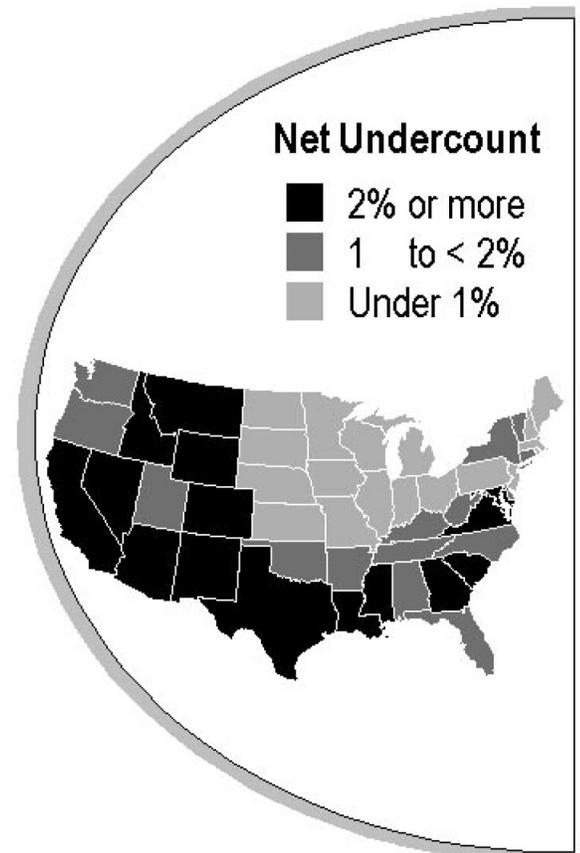


Figure 4b. Alternate metadata format for 1990 undercount data.

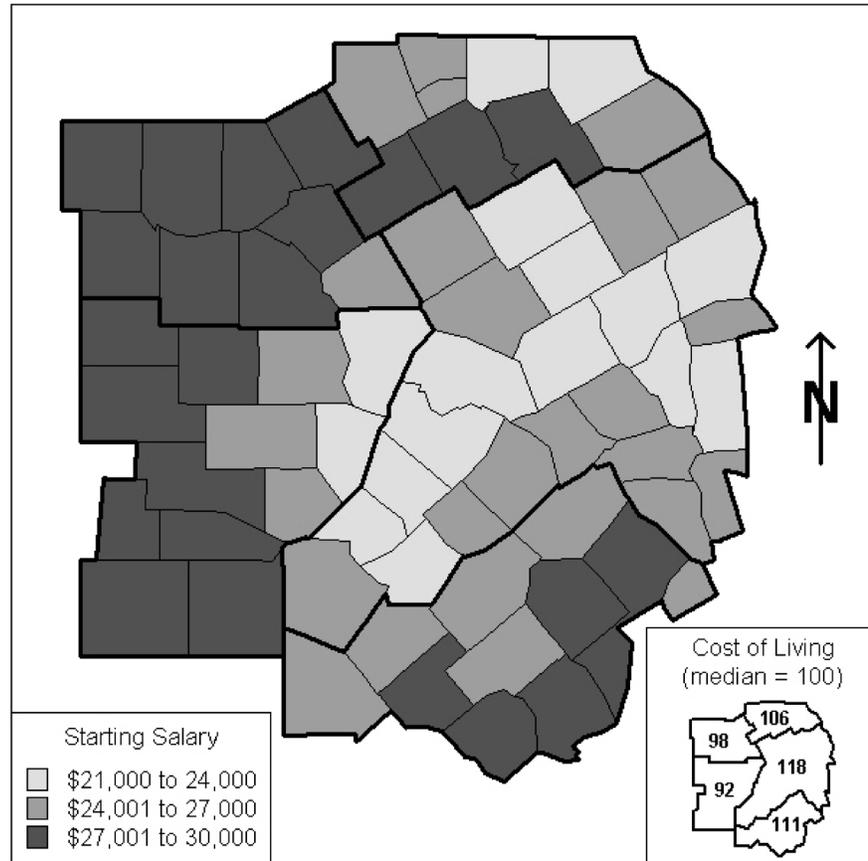


Figure 5. Starting teacher salary by township. Text-label metadata diagram showing cost of living.

nate the mental overlay problem noted by McGranaghan (1993). As this map has very little extra space, the metadata diagram has been skeletonized to county boundaries, a title, and printed text. Though this would be inadvisable for the main map, it is effective in the metadata diagram because of the small number of areal units.

DISCUSSION AND RECOMMENDATIONS

A metadata diagram can be added to most thematic maps with a minimum of extra effort on the part of the cartographer. Sometimes, as in the undercount and population density examples above, the information needed to create the reliability diagram was readily available from the same source as the data for the main map. For example, undercount information is available on the Census Bureau's website (www.census.gov). In all of the above examples, simplicity and clarity have been emphasized as the primary principles of design. To be effective, a metadata diagram must communicate quality or background information efficiently and without ambiguity. Simplicity is equally important to the cartographer facing a production deadline. If metadata diagrams can be created quickly, they have the potential to become more common and to enhance the cartographic understanding of more users.

More complex quality problems than those presented here do exist, but the selected examples illustrate several of the most common problems. In this situation—when the benefits to the map user (better communication of information, improved understanding of data limitations) clearly out-

“A metadata diagram can be added to most thematic maps with a minimum of extra effort on the part of the cartographer.”

weigh the cost to the cartographer—metadata diagrams should always be included. In situations where it is more difficult to obtain geographically-referenced quality information, cartographers should consider whether the quality problem is serious enough to merit the extra investigation or data processing. Where appropriate, these diagrams have the potential to improve cartographic communication by enhancing the comprehension of the map-viewing public.

1. Ideally the metadata map would be parallel to and of the same size as the data layer, as illustrated in Howard and MacEachren (1996). This works online but not on paper, where publication costs dictate that space must be conserved. The importance of “conservation of space” as a motivating factor in cartographic design has yet to be fully investigated. Additional online space has no marginal cost. Thus cartographic design for the Internet need not fit into the confines of a rectangular sheet of paper. Most maps posted online today are replicas of paper originals, but entirely new principles of cartographic design may be expected to arise as online mapping becomes more important.
2. Most maps currently available on the internet are non-animated images that may be readily printed on paper. Examples include online road maps and maps of census data. Printing an online map is, in fact, a good test of whether it is a static or dynamic display of information: static maps look the same in either format, something clearly untrue about maps with dynamic elements.
3. Further uncertainty is introduced by the ability of humans to respond falsely to surveys. Measurements with mechanical instruments can be redone, but one cannot “repeat the experiment” to check the results of a human study because people can choose to respond differently each time.

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Cartographic Guidelines for Geographically Masking the Locations of Confidential Point Data

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This research proposes cartographic guidelines for presenting confidential point data on maps. Such guidelines do not currently exist, but are important for governmental agencies that disseminate personal data to the public because these agencies have to balance between the citizens' right to know, and preserving a citizen's right to privacy.

In an experiment, participants compared an original point pattern of confidential crime locations with the same point pattern being geographically masked. Ten different masking methods were tested. The objective was to identify appropriate geographic masking methods that preserve both the confidentiality of individual locations, and the essential visual characteristics of the original point pattern. The empirical testing reported here is a novel approach for identifying various map design principles that would be useful for representing confidential point data on a map.

The results of this research show that only two of the ten masking methods that were tested yield satisfactory solutions. The two masking methods include aggregating point locations at either (1) the midpoint of the street segment or (2) at the closest street intersection. The cartographic guidelines developed from this research suggest a combination of both masking strategies. Future research should focus on the refinement and further testing of these, and other alternative masking methods.

Keywords: Geographic masking, cartographic design, privacy

I. Introduction

Different governmental agencies have long stored information in restricted access databases. The advent of on-line data entry and analysis, and subsequent distribution of data to the public, has created a need for a more rigid set of visualization rules that preserve individual confidentiality. For example, when crime data are disseminated to the public in the form of crime maps via the Internet, law enforcement agencies have to balance between citizens' rights to know the dangers they face in their neighborhoods, while at the same time preserving the confidentiality rights of the victim. Similarly in health data, it is important to know which "risks" pregnant mothers face in particular neighborhoods, while preserving the actual birth outcomes of women living in those neighborhoods.

In this paper we discuss different geographic masking strategies of crime location records that protect the confidentiality of individuals, and at the same time preserve essential visual characteristics of the true, original spatial distribution of those records. Five different global and five different local geographic masking methods (for a total of ten) were tested and compared. The decision to distinguish between global and

local methods reflects a recent trend in spatial analysis to develop local analysis tools as extensions of already existing global measurements (Getis and Ord, 1996; Fotheringham, Brunsdon and Charlton, 2002; Anselin, 2003). Armstrong, Rushton and Zimmerman (1999) introduced the term 'geographic masking' into the literature, suggesting similar geographic masking methods that are applied in this research. Whereas their research discusses the influence geographically masked data have on the results of geographically based analyses, the research reported here identifies acceptable design solutions for presenting confidential point data on a map. Acceptable design solutions define any geographic masking method that would preserve as many visual spatial characteristics as possible, while reducing the likelihood of individual identification to an acceptable level. A review of the literature suggests that the methods reported here are the first to utilize empirical perceptual studies to assess methods for presenting confidential point data on maps. This work also continues a long-standing tradition of empirical research in map design as a paradigm for eliciting and formalizing cartographic design knowledge (Leitner, 1997; Leitner and Buttenfield, 2000; Aerts, Clarke and Keuper, 2003).

The subject matter of this research relates to an area of geography and related disciplines that has been receiving a fair amount of attention lately, especially as it pertains to the mapping of disease and crime information (Armstrong, Rushton and Zimmerman, 1999; Wartell and McEwen, 2001; Monmonier, 2002; Leitner and Curtis, 2003). The intention of the research reported here is to develop appropriate guidelines for mapping the location of individual-level data that is considered to be confidential. Such guidelines do not currently exist, but their development becomes increasingly important as more and more governmental agencies disseminate their data on maps via the Internet. To put it differently, this research is concerned with masking locations of individual-level data, rather than the attribute information that could be associated with such locations. Masking strategies for attribute data have already been widely discussed in the literature for some time (Duncan and Pearson, 1991; Cox, 1994; 1996).

Results of this research are of interest to any agency needing to display confidential data at neighborhood levels. As data become more widely available on the WEB, and as the public increasingly realizes the power of local level rather than global level aggregate maps, the need for accurate and easy geographic masking of confidential data will be of utmost importance to all governmental agencies. According to a website updated by the Mapping and Analysis for Public Safety (MAPS) program (sponsored by NIJ), about 50 local law enforcement agencies in the US now provide online data/maps (see <http://www.ojp.usdoj.gov/nij/maps/weblinks.html>). Access to this type of data will certainly continue to increase.

II. Methodology

A. Data

All incident locations displayed in the test maps were the residences of homicide victims in the city of Baton Rouge between 1991 and 1997. There were a total of 301 homicide victims, of which 285 were successfully address-matched (95% success rate) to the Baton Rouge street network. The street network and the census tract boundaries were from the Census 2000 TIGER/Line Data from the U.S. Bureau of the Census. All data were projected to the Universal Transverse Mercator coordinate system, North American Datum 83 (NAD83), Zone 15 North.

"The intention of the research reported here is to develop appropriate guidelines for mapping the location of individual-level data that is considered to be confidential."

B. Preparation of test maps

Only a subset of all incident locations was selected for inclusion in the test maps. This subset of incident locations was displayed in yellow on top of a blue background. In one-third of the test maps, no additional information was shown. In the second one-third, census tract boundaries were added to the test maps in black. The remaining one-third of the test maps included the complete street network in dark blue.

Incident locations were geographically masked at either the global or local level. Global geographic masking means that every single incident location was spatially displaced by the same exact amount (Figure 1). For three of the five local geographic masking methods, a regular grid was first superimposed over the selected study area. Each grid cell was a square measuring 500 meters per side. Incident locations falling into the same grid cell were then spatially displaced by the same exact amount, but this displacement vector changed randomly between grid cells (Figure 2). The regular grid was used in the preparation of the test maps but not shown on the maps that were included in the experiment.

C. Global geographic masking methods

Figure 1 compares the original incident locations (Figure 1-A) with the same incident locations after being geographically masked by five different global masking methods (Figure 1-B through 1-F). For privacy concerns only the blue background was used. Three incident locations were labeled to show the effect that each global masking method had on the incident locations.

“Incident locations were geographically masked at either the global or local level.”

In Figure 1-B the original incident locations were flipped about the horizontal central axis of the map, and subsequently placed on top of the closest street segment. In Figure 1-C all incident locations were flipped about the vertical central axis of the map and then moved on top of the closest street segment. In Figure 1-D incident locations were flipped about both the horizontal and the vertical central axes of the map and then placed on top of its closest street segment. In Figure 1-E all incident locations were rotated around the map center either by 60° to the right or by 120° to the left (Figure 1-F) and subsequently placed on top of the closest street segment.

D. Local geographic masking methods

Figure 2 displays the original incident locations (Figure 2-A) together with the same incident locations after being geographically masked by five different local masking methods (Figure 2-B through 2-F). To protect the privacy of the individual, only the blue background was used in all maps. Four sample locations were selected and labeled so their locations could be traced between the original and the five locally masked maps. Note that Figure 2 shows only a small portion of each test map that was used in the experiment.

The first local masking method aggregated incident locations at the midpoint of their street segments (Figure 2-B). A street segment was defined as the portion of a street between two adjacent street intersections. In Figure 2-C incident locations were aggregated to their closest street intersection, which was defined as the intersection of three or more streets. The next three local masking methods were based on a regular grid. In the first instance, incident locations were flipped either about the vertical, horizontal, or both central axes of each grid cell and then moved on top of

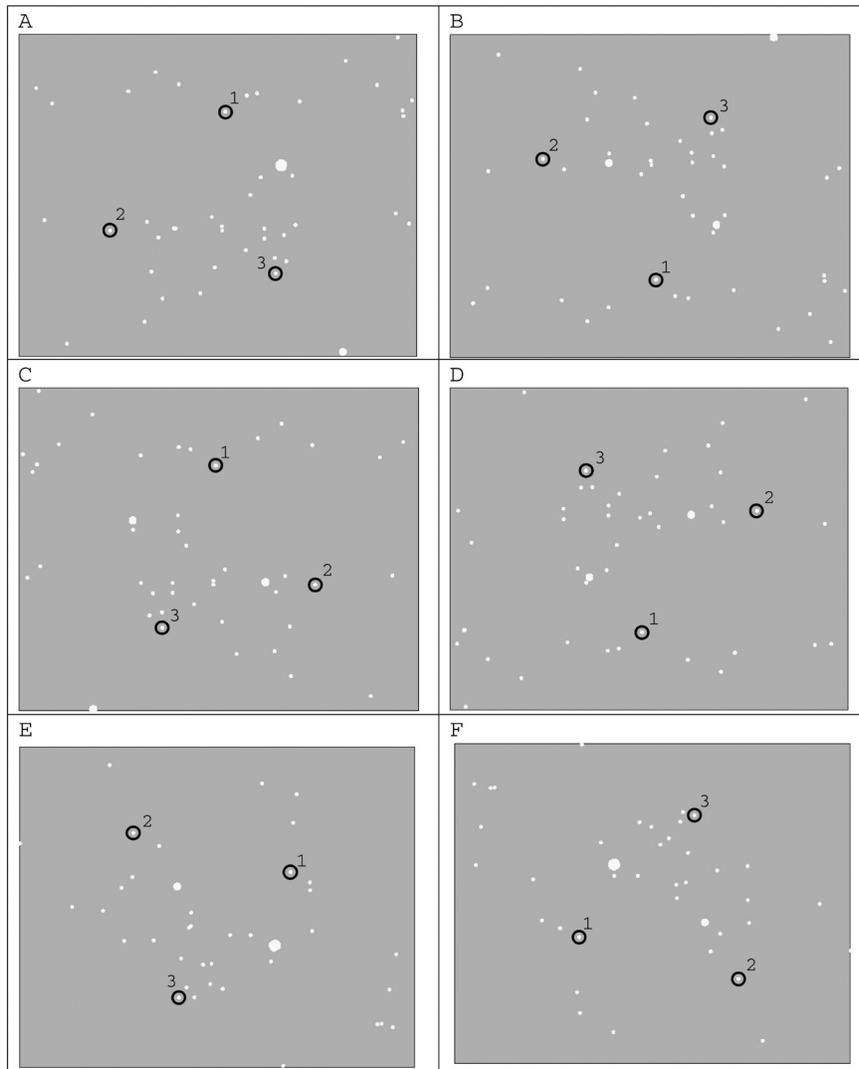


Figure 1. Global geographic masking methods used in this experiment.

A) Original incident locations, B) flipping about horizontal central axis of the map, C) flipping about vertical central axis of the map, D) flipping about both central axes of the map, E) rotating around the map center by 60° to the right, F) rotating around the map center by 120° to the left. (See page 83 for a reduced color version)

its closest street segment. The type of flipping changed randomly between the cells of the regular grid (Figure 2-E). For example, the incident location labeled as #1 was flipped vertically; the other three incident locations (#2, #3 and #4) were each flipped horizontally. In Figure 2-D incident locations were first rotated by some random degrees around the center of each grid cell and then placed on top of the closest street segment. The incident location #1 was rotated by 120° to the left; #2 by 60° to the right; #3 by 240° to the right; and #4 by 120° to the right. In Figure 2-F incident locations were first translated by some random distances and then moved on top of their closest street segment. The incident location labeled as #1 was translated 150 meters in x- and 350 meters in y-direction from the lower left corner of its grid cell; #2 was translated 300 meters in x and 400 meters in y; #3, 450 meters in x and 50 meters in y; and #4, 300 meters in x and 200 meters in y.

The size of the grid cells, the angles of rotation and the translation distances were chosen arbitrarily when masking point patterns. Clearly, different choices might have yielded different results. For example, smaller

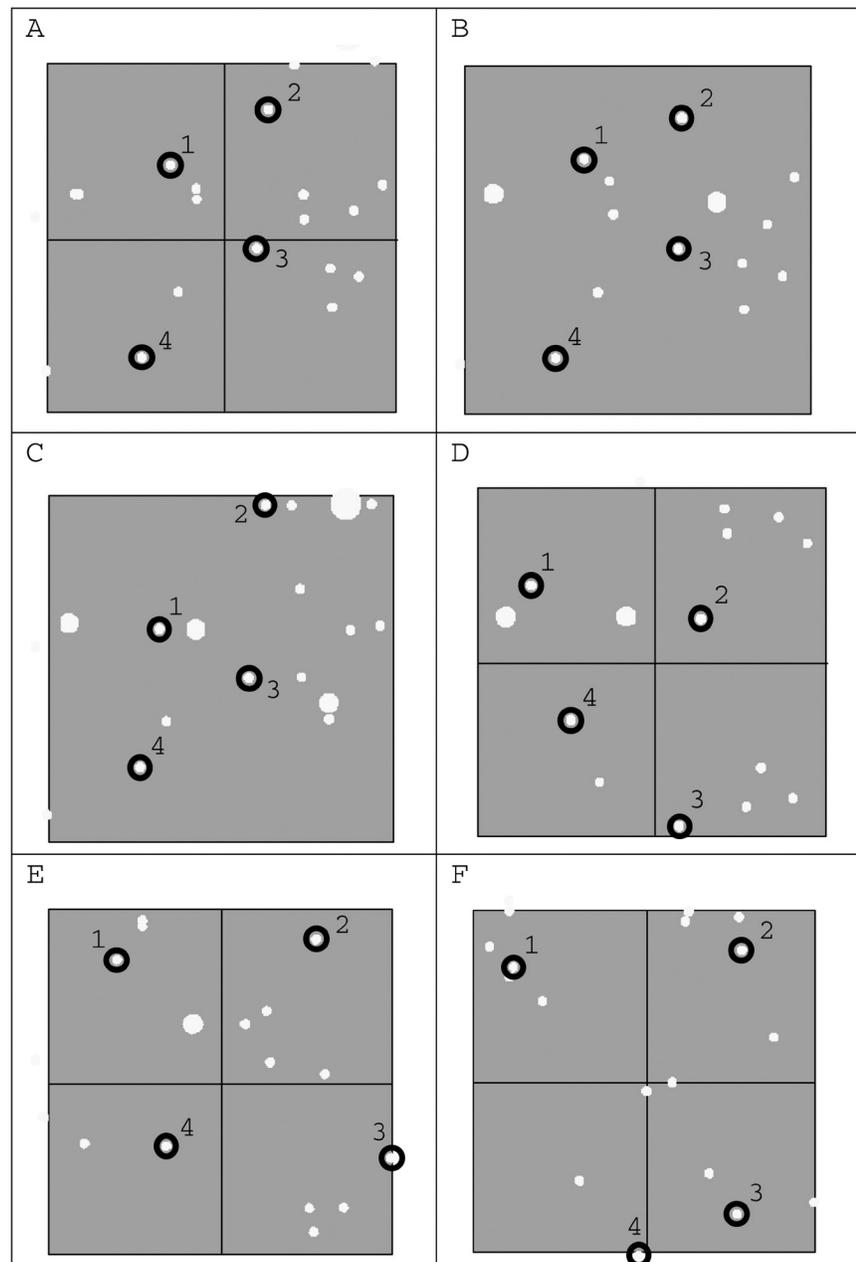


Figure 2. Local geographic masking methods used in the experiment (only a portion of the entire test map is shown).

A) Original incident locations, B) spatial aggregation at the midpoint of the street segment, C) spatial aggregation at the closest street intersection, D) flipping randomly either about the vertical, horizontal or both central axes of each grid cell, E) rotating by some random degree around the center of each grid cell, F) translating by some random distance.

(See page 83 for a reduced color version)

rotation angles and shorter translation distances in Figures 2-E and 2-F would have resulted in shorter point movements. Consequently, these two masked point patterns would have been more similar to those patterns exhibited in Figures 2-B and 2-C. In addition, smaller cell sizes would have shortened point movements and vice versa. Investigating the impact differently masked point patterns have on people's visual perception is new — the selection of all masking methods used in this study, including the translation distances, rotation angles and the size of the grid cells, should be understood as an exercise in exploratory analysis. It is hoped

that results of this research will create a base line for the development of guidelines for geographic masking.

III. Procedure

Two experiments were conducted, one testing 30 map pairs, the other testing 34 map pairs. One map of each pair always showed all incidents in their correct location. In the second map, all incident locations were geographically masked, either locally or globally. All five local and all five global geographic masking methods (see Section II) were tested in each experiment. The incidents in each map pair were displayed in yellow on top of a blue background (Figure 4). The experiment with 30 map pairs included each of the ten masked point patterns for each of the three different backgrounds (i.e., no background, census tract boundaries, and street network information). For these 30 map pairs, participants were asked to identify hot spot areas in the masked point pattern. The experiment with 34 map pairs included the same 30 map pairs tested in the first experiment—again hot spot areas were marked in the masked point pattern. However, for the additional four map pairs participants were asked to identify hot spots in the original or unmasked point pattern, rather than in the masked point pattern. For all map pairs in both experiments, participants did not know which point pattern was masked and which one was unmasked. The order of presentation of the map pairs in each experiment was random.

“... all incident locations were geographically masked, either locally or globally.”

Each slide in this presentation shows two point pattern maps that are displayed next to each other.

Your first task is to compare the two point patterns and decide how similar or different they are.

Please make this decision by choosing a whole number between **1** and **7**. The number **1** means that the two point patterns are **VERY SIMILAR** and the number **7** means that they are **VERY DIFFERENT**.

Your second task is to identify areas within one of the two point pattern maps that show a **high concentration of points**. Mark those areas with a pen or pencil directly on the hard copy maps provided.

There is no time limit to complete this experiment.

Thank you for your participation!

“For all map pairs in both experiments, participants did not know which point pattern was masked and which one was unmasked.”

Figure 3. First slide of the experiment, including the instructions.

Each experiment was put together as a power point presentation. In addition, all participants received a color printout (hard copy) of the entire presentation. The first slide of the presentation included the instructions (see Figure 3); all other slides included the map pairs; one map pair per each slide (Figure 4). Instructions were briefly repeated at the bottom of each slide showing a map pair. Overall, 82 participants completed the experiment. 44 of those participants were students from computer cartography, geographic information systems, and methods of spatial analysis classes at Louisiana State University in Baton Rouge, LA. The remaining

38 participants were students from two introductory spatial analysis and one cartography and visualization classes from the School of Geoinformation, University of Applied Science located in Villach, Austria.

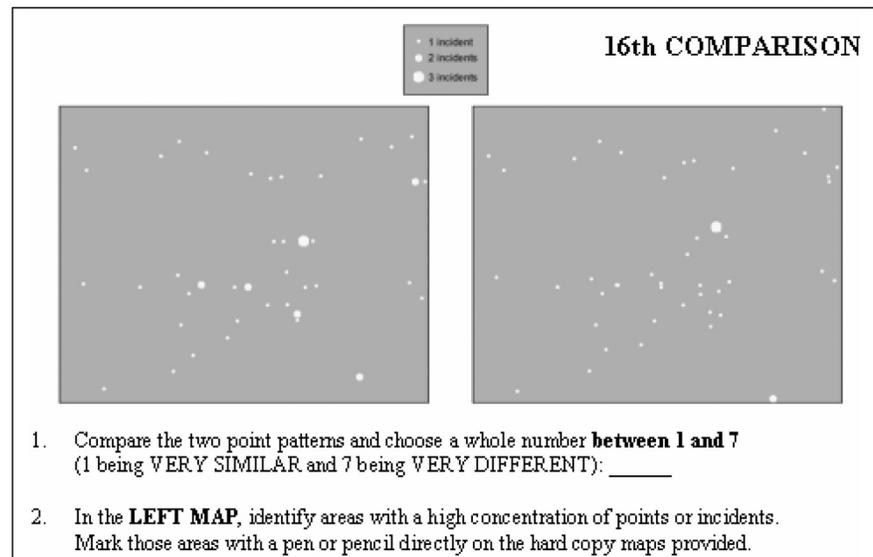


Figure 4. Example of a pair of test maps included in the experiment. All incident locations in the left map are locally masked by spatially aggregating them to their closest street intersection. All incidents in the right map are shown with their true, unmasked location. (See page 83 for color version)

Experiments were conducted during class time, lasting between 13 and 26 minutes. For each map pair, participants were asked to complete two tasks. The first task was to compare the two point pattern maps and decide if the two patterns were similar or different. Participants were asked to rank the two point patterns as “very similar” (rank value of 1) to “very different” (rank value of 7). This number was recorded on the hardcopy maps. The second task involved identifying areas within one of the two point pattern maps (in most instances this was the map for which the incident locations were geographically masked, but the participant did not know that) that showed a high concentration of incidents. Test participants were asked to mark those areas, if they thought they existed, with a pen or pencil directly onto the hardcopy maps.

IV. Results

One objective of this study is to investigate how much each geographic masking technique changes the original pattern of incident locations. This objective is addressed in two ways, first, by comparing the change in the overall point pattern and secondly, by comparing the change in the number and location of hot spots. Test participant’s responses to how similar the (overall) original and the masked pattern were are summarized in two frequency tables. Table 1 includes the results for the five global, Table 2 for the five local masking techniques.

The results in Table 1 and Table 2 show that the selection of a masking technique is very important. The differences between the masking techniques can be seen in the differences between the relative frequency distributions. Additionally, the mean rank for each masking technique was calculated. The closer the mean rank is to one, the more similar the original and the masked point pattern were perceived. The closer the mean

“One objective of this study is to investigate how much each geographic masking technique changes the original pattern of incident locations.”

Similarity between original and masked point pattern	Flipping about vertical central axis of the map	Rotating around the map center by 60° to the right	Flipping about horizontal central axis of the map	Flipping about both central axes of the map	Rotating around the map center by 120° to the left
1 (very similar)	3.7	1.1	2.4	2.8	2.8
2	19.5	4.9	7.3	6.5	2.8
3	22.4	13.4	10.6	8.5	4.1
4	23.2	18.7	13.5	11.8	10.2
5	17.1	23.3	18.0	24.4	14.6
6	7.7	22.6	27.3	25.2	28.0
7 (very different)	6.5	15.9	20.8	20.7	37.4
Mean Rank	3.80	4.90	5.02	5.07	5.65
Total number of map comparisons	246	283	245	246	246

Table 1. Comparison between the original and five different global geographically masked point patterns. All entries in the Table are percentages of map comparisons falling into one of seven categories ranging from 1=very similar to 7=very different. The percentages are calculated from all map comparisons irrespective of background information (i.e., no background, census tract and street network information).

rank is to seven, the more different the two point patterns were perceived. A mean rank lower than four indicates that the two point patterns were perceived to be more similar than different from each other. Accordingly, mean ranks above four indicate that the two point patterns were perceived to be more different than similar. In both Tables, the total number of map comparisons for each masking technique varies between 245 and 283. This can be explained by participants missing the answer to this question and/or by the difference in the total number of test maps used between the different groups of test participants.

Similarity between original and masked point pattern	Spatial aggregation at midpoint of street segment	Spatial aggregation at street intersection	Rotating by some random degree around the center of each grid cell	Flipping randomly either about the vertical, horizontal or both central axes of each grid cell	Translating by some random distance
1 (very similar)	43.3	15.9	4.5	2.0	0.8
2	42.0	45.5	15.9	12.2	4.1
3	9.4	24.0	31.3	17.9	14.2
4	3.3	10.6	20.3	17.9	17.9
5	0.8	2.0	17.5	24.4	22.0
6	0.8	2.0	8.5	18.7	21.5
7 (very different)	0.4	0.0	2.0	6.9	19.5
Mean Rank	1.80	2.43	3.64	4.34	4.99
Total number of map comparisons	245	246	246	246	246

Table 2. Comparison between the original and five different local geographically masked point patterns. All entries in the Table are percentages of map comparisons falling into one of seven categories ranging from 1=very similar to 7=very different. The percentages are calculated from all map comparisons irrespective of background information (i.e., no background, census tract and street network information).

V. Analysis

Overall, the mean rank varies greatly from a low of 1.80 to a high of 5.65. The lowest mean rank (1.80) is calculated for the masking technique that aggregates point locations at the midpoint of its street segment, followed by the masking technique that aggregates point locations at their closest street intersection (mean rank = 2.43). These two local masking techniques are clearly below a mean rank of four, which means that they were perceived rather similar (than different) to the original point pattern. Two additional masking methods yield a mean rank less than four, including the local masking method 'rotating by some random degree around the center of each grid cell' (mean rank = 3.64) and the global masking method 'flipping about the vertical central axis of the map' (mean rank = 3.80) (Tables 1 and 2).

Altogether, three local and one global masking method are the only ones below a mean rank of four. This means that they are the only masking methods of all ten methods tested for which the original and the masked point pattern were perceived to be more similar than different from each other. This further means that they are the only four masking methods identified in this research that comply with one important objective of an appropriate masking technique for the location of confidential data, namely to preserve as much as possible the visual characteristics between the original and the masked point pattern. Accordingly, the remaining four global and the other two local masking methods are inappropriate and should not be used.

“ . . . three local and one global masking method are the only ones below a mean rank of four. . . they are the only masking methods of all ten methods tested for which the original and the masked point pattern were perceived to be more similar than different from each other.”

If there were a choice between the three local and the one global geographic masking method with a mean rank below four, which one should be chosen? The obvious choice would be the masking method with the lowest mean rank. In order to find out, if 1.80 is a statistically significant lower mean rank than any one of the other three mean ranks (2.43, 3.64, or 3.80), a Mann-Whitney U^1 test was applied. Analysis shows that a mean rank of 1.80 is indeed significantly lower than a mean rank of 2.43 (z-test statistic = -7.530, p-value < 0.001). From this result it follows that a mean rank of 1.80 is also significantly lower than a mean rank of 3.64 and 3.80. Additional analyses show that a mean rank of 2.43 is lower than a mean rank of 3.64 (z-test statistic = -9.992, p-value < 0.001), and that there is no difference between a mean rank of 3.64 and 3.80 (z-test statistic = -0.906, p-value = 0.365). Consequently, when there is a choice between the four different masking methods with a mean rank below four, then the first choice would be to aggregate points at the midpoint of its street segment. The second choice would be to aggregate points at their closest street intersection and the third choice would be to either rotating incident locations by some random degrees around the center of each grid cell or flipping all incident locations about its vertical central axis of the map.

The order of mean ranks measuring the similarity between an original and different masked point patterns is purely based on perceptual (subjective) interpretations of test participants. An interesting question to ask is if the order would remain the same when the similarity between two point patterns is measured with a statistical (objective) method. To answer this question the straight-line distances from each incident location in the original point pattern were measured to its nearest neighbor in each of the four masked point patterns with a mean rank lower than four (see Tables 1 and 2) and mean distances calculated. A shorter mean distance between an original and its masked point pattern would be interpreted as a higher similarity, whereas a longer mean distance would indicate a lower similarity. For this research the shortest mean nearest

neighbor distance of 38.04 meters was calculated between the original point pattern and the masked point pattern that aggregates points at the midpoint of its street segment. The second mean nearest neighbor distance of 56.40 meters was calculated between the original point pattern and the masked point pattern that aggregates points at their closest street intersection. The third shortest mean nearest neighbor distance of 131.15 meters was calculated between the original point pattern and the masked point pattern that rotates incident locations by some random degrees around the center of each grid cell. The longest mean nearest neighbor distance of 158.00 meters was derived between the original and the masked point pattern that flips incident locations about its vertical central axis of the map. These results show that the shortest mean distance was calculated between the same original and masked point patterns that also yielded the lowest mean rank. Similarly, the second shortest mean distance was calculated between the same two point patterns that also yielded the second lowest mean rank. The same is true for the third and fourth shortest mean distances. In general, the results show that no differences were found whether the similarity (between one original and four different masked point patterns) was measured by a perceptual (subjective) or a statistical (objective) technique. This agreement is important, as it supports the robustness of the experimental design and perceptual framework used to collect data for this research.

Clearly, the mean ranks for the three methods that mask their incident locations locally within each grid cell (see Figure 2) depend on the chosen grid cell size. It is expected that the smaller the cell size, the lower the mean rank would be. Therefore, it is quite possible that with a small enough cell size, all three local masking methods would yield a mean rank lower than four. Additional experiments should therefore be conducted to explore the relationship between cell size and perceived similarity between an original and a geographically masked point pattern. The goal would be to possibly identify a small enough cell size resulting in a mean rank lower than four.

“Additional experiments should therefore be conducted to explore the relationship between cell size and perceived similarity between an original and a geographically masked point pattern.”

VI. Analyzing the influence of different base map information

The previous section identified four masking methods that were appropriate for the display of confidential point locations. This section analyzes if different base map information might influence participants' perception of the similarity between the unmasked and any of these four masked point patterns. Results in Table 3 reveal that the mean rank changes somewhat across the three base maps for each of the four masking methods. As a reminder, the closer the mean rank is to one, the more similar the masked and unmasked point pattern is. A value above four indicates that the masked point pattern is more different (than similar) to the original, unmasked point pattern. All mean ranks are below four, with the exception of the masking method 'flipping about its vertical central axis of the map' with the street network as the base map. Three of the four masking methods yield the lowest mean ranks when census tracts are used as the base map, whereas, two of the four masking methods show the highest mean ranks when the base map consists of the street network. Due to the small sample size, one has to be cautious to not draw general conclusions from these results. Again, additional research is warranted.

The results further show that for each masking method, the variability in the mean ranks across the three base maps seems to increase with higher mean ranks. Are these variations statistically significant for any of the four masking methods?

Similar / Different	Spatial aggregation at midpoint of street segment			Spatial aggregation at street intersection		
	No base map	Census tract boundaries	Street network	No base map	Census tract boundaries	Street network
1 (very similar)	36.6	45.1	48.1	18.3	20.7	8.5
2	41.5	45.1	39.5	43.9	39.0	53.7
3	12.2	7.3	8.6	23.2	29.3	19.5
4	4.9	2.4	2.5	11.0	9.8	11.0
5	2.4	0.0	0.0	1.2	1.2	3.7
6	1.2	0.0	1.2	2.4	0.0	3.7
7 (very different)	1.2	0.0	0.0	0.0	0.0	0.0
Mean Rank	2.04	1.67	1.70	2.40	2.32	2.59
Total number of map comparisons	82	82	81	82	82	82
Rotating by some random degree around the center of each grid cell						
Similar / Different	Rotating by some random degree around the center of each grid cell			Flipping about vertical central axis of the map		
	No base map	Census tract boundaries	Street network	No base map	Census tract boundaries	Street network
1 (very similar)	9.8	2.4	1.2	2.4	3.7	4.9
2	29.3	7.3	11.0	14.6	34.1	9.8
3	28.0	30.5	35.4	26.8	12.2	28.0
4	14.6	28.0	18.3	23.2	24.4	22.0
5	12.2	19.5	20.7	20.7	14.6	15.9
6	4.9	11.0	9.8	4.9	9.8	8.5
7 (very different)	1.2	1.2	3.7	7.3	1.2	11.0
Mean Rank	3.10	3.93	3.90	3.89	3.46	4.04
Total number of map comparisons	82	82	82	82	82	82

Table 3. Comparison between the original and the masked point pattern for four different geographic masking methods. All entries are percentages of test participants falling into one of seven categories ranging from 1=very similar to 7=very different.

To this end, a Kruskal-Wallis H test² was applied to explore if test participants' responses varied significantly due to different base map information. This test was carried out for the four masking methods with a mean rank below four. Results revealed that three of the four masking methods did not show statistically significant differences across the three different base maps. When incidence locations are aggregated at the midpoint of its street segment then the Kruskal-Wallis H test calculated a chi-square statistic of 4.501, with a p-value of 0.105 and two degrees of freedom. When incidence locations are aggregated at the closest street intersection, then the results yielded a chi-square statistic of 1.361, with

a p-value of 0.506 and two degrees of freedom, respectively. The corresponding test statistics and probabilities for 'rotating by some random degree around the center of each grid cell' and 'flipping about its vertical central axis of the map' are a chi-square statistic of 20.228 with a p-value of 0.000 and a chi-square statistic of 5.743 with a p-value of 0.057, respectively.

Based on a significance level of 0.01, these results mean that for three of the four masking methods analyzed, it would not matter if a base map includes political-administrative boundaries, or the street network, or no base map at all. The only significant chi-square statistic was calculated for the local masking method that rotates incident locations by some random degree around the center of each grid cell.

VII. Analyzing hot spots for different masking methods and different base maps

Areas within each point pattern that show a high concentration of incident locations are usually of great interest and worthwhile to be studied further. Any good and appropriate masking method needs to preserve the number, locations, sizes and shapes of these 'hot spot' areas. For this reason, participants were asked to identify high concentrations of incident locations in all geographically masked maps and in the original, unmasked maps. Hot spot areas for those four masked point patterns that were perceived to be more similar than different from the original unmasked point pattern are displayed in Figure 5. These hot spots are compared with hot spots from the unmasked point pattern for each of the three different base maps. Base map information was not included in Figure 5, so that hot spots would be clearly visible.

In general, the results in Figure 5 clearly show that the size, shape, location and number of hot spots change little *across* the different types of base maps. However, differences can be observed *between* some of the masking methods. Specifically, there seems to be much agreement in the size, shape, location and number of hot spots between the original, unmasked point pattern, and the two masked point patterns that aggregate their incident locations either at the midpoint of its street segment or at their closest street intersection. This is an important result and it makes these two local masking methods very useful and appropriate tools to visualize the location of confidential data. A further observation is that of a hierarchical arrangement of differently sized hot spots. There are two small (local) hot spots to the right of the center of each map. These two are combined into one medium-sized hot spot. Then there is a larger (regional) hot spot apparent across the lower portion of each map that encloses the two small and the one medium-sized hot spot.

However, differences in the size, shape, location and number of hot spots are visible when comparing the original point patterns with the other two masked point patterns. For example, when the point pattern is masked by rotating point locations by some random degrees around the center of each grid cell then a distinct, local hot spot appears in the upper half of the map, just right of the center. This particular hot spot is not visible in the original and in any of the other masked point patterns. This points to a particular danger of using an inappropriate masking method, namely the likelihood of an incident cluster to appear in a neighborhood of a city, where such a cluster does not exist in reality. If this information is distributed to the public, consequences may include false perceptions regarding the nature of the distribution and/or unfair informal redlining methods employed by some insurance and banking companies. For

"Areas within each point pattern that show a high concentration of incident locations are usually of great interest and worthwhile to be studied further."

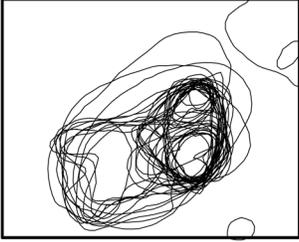
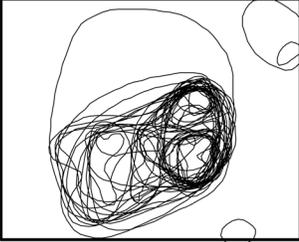
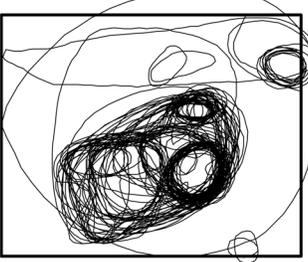
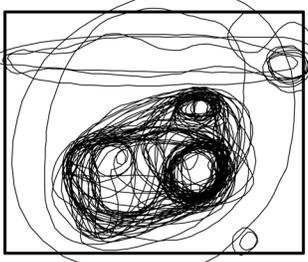
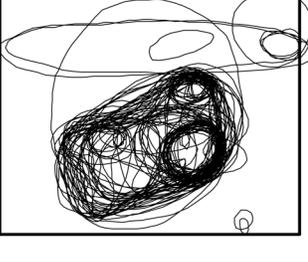
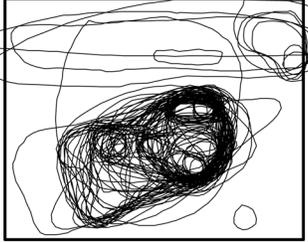
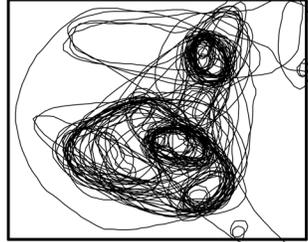
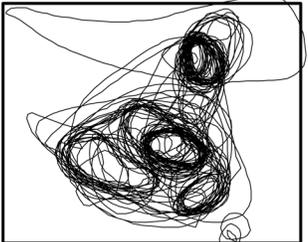
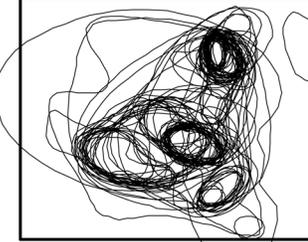
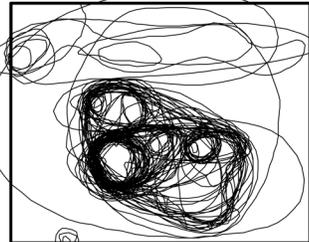
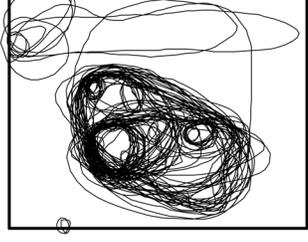
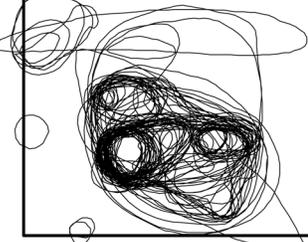
	No base map information	Census tract boundaries as base map information	Street network as base map information
Original, geographically unmasked point pattern			
Geographically masked by aggregating point locations at the midpoint of its street segment			
Geographically masked by aggregating point locations at their closest street intersection			
Geographically masked by rotating point locations by some random degree around the center of each grid cell			
Geographically masked by flipping point locations about the vertical central axis of the map			

Figure 5. Comparing hot spots between the original and four different geographically masked point patterns for three different base maps. The base map information is not included in any of the maps.

the global masking method, hot spots, when compared to the original, unmasked point pattern, are clearly flipped about the vertical central axis of the map. Again, hot spots appear in parts of the city, where they do not exist in reality. For this reason, the two masking methods 'rotating by some random degree around the center of each grid cell' and 'flipping

about the vertical central axis of the map' are inappropriate and should not be used.

Figure 5 provides a visual comparison of hot spots between the different test maps. A tabular comparison of the same information is shown in Table 4, in which the number of hot spots (none, one, two, more than two) for the masked and unmasked point patterns for all three base maps is listed. Relative percentages are shown in square parenthesis. For the category 'more than two hot spots', the number of hot spots (3, 4, 5, etc.) is shown in round parenthesis. For this category, the relative percentages are calculated only for the total number of maps with more than two hot spots.

	Number of hot spots	No base map information	Census tract boundaries as base map information	Street network as base map information
Original, geographically unmasked point pattern	No hot spot	1 [2.7%]	0 [0.0%]	2 [5.4%]
	One hot spot	25 [67.6%]	26 [70.3%]	21 [56.8%]
	Two hot spots	10 [27.0%]	7 [18.9%]	12 [32.4%]
	More than two hot spots	1 (3) [2.7%]	3 (3), 1 (4) [10.8%]	2 (3) [5.4%]
	TOTAL MAPS	37	37	37
Geographically masked by aggregating point locations at the midpoint of its street segment	No hot spot	3 [3.7%]	1 [1.2%]	1 [1.2%]
	One hot spot	49 [59.8%]	55 [67.1%]	60 [73.2%]
	Two hot spots	19 [23.2%]	19 [23.2%]	11 [13.4%]
	More than two hot spots	5 (3), 5 (4), 1 (5) [13.4%]	3 (3), 4 (4) [8.5%]	8 (3), 2 (4) [12.2%]
	TOTAL MAPS	82	82	81
Geographically masked by aggregating point locations at their closest street intersection	No hot spot	3 [3.7%]	4 [4.9%]	10 [12.2%]
	One hot spot	50 [61.0%]	57 [69.5%]	50 [61.0%]
	Two hot spots	21 [25.6%]	14 [17.1%]	14 [17.1%]
	More than two hot spots	5 (3), 2 (4), 1 (5) [9.8%]	7 (3) [8.5%]	7 (3), 1 (4) [9.8%]
	TOTAL MAPS	82	82	82
Geographically masked by rotating point locations by some random degree around the center of each grid cell	No hot spot	9 [11.0%]	9 [11.0%]	1 [11.0%]
	One hot spot	30 [36.6%]	36 [43.9%]	42 [51.2%]
	Two hot spots	28 [34.1%]	17 [20.7%]	17 [20.7%]
	More than two hot spots	11 (3), 2 (4), 2 (6) [18.3%]	3 (16), 4 (4) [24.4%]	7 (3), 7 (4) [17.1%]
	TOTAL MAPS	82	82	82
Geographically masked by flipping point locations about vertical central axis of the map	No hot spot	2 [2.4%]	3 [3.7%]	10 [12.2%]
	One hot spot	51 [62.1%]	55 [67.1%]	44 [53.7%]
	Two hot spots	16 [19.5%]	15 [18.3%]	17 [20.7%]
	More than two hot spots	9 (3), 2 (4), 2 (5) [19.5%]	5 (3), 2 (4), 1 (5), 1 (6) [11.0%]	9 (3), 1 (4), 5 (1) [13.4%]
	TOTAL MAPS	82	82	82

Table 4. Comparing the number of hot spots between the original and four geographically masked point patterns for three different base maps.

In most instances, the majority of all test participants identified exactly one hot spot in each map, independent of the base map information and whether the point pattern was masked or not. Two hot spots were identified by approximately one-quarter of all test participants. Relatively few participants identified no hot spots, or identified more than two hot spots. The highest number of hot spots identified was six (Table 4).

VIII. Preserving the privacy of confidential incidence locations

The following final analysis investigates to what extent one might be able to identify an individual incident location after this location has been geographically masked. Recall that each incident location identifies the street address where a homicide victim resided. Consequently, this section discusses to what extent the privacy of the confidential location of an individual residence would be preserved if that location has been geographically masked.

To answer this question, a sample of fourteen different street addresses were randomly selected from a total of 48 addresses used in this research. All addresses are located in a residential neighborhood in Baton Rouge with mostly single-family houses. Churches, schools, office buildings, etc. are interspersed between the residences. Each of the fourteen residences associated with the street address from the sample was visited, and the number of residences on either side of the street segment that included the residence of interest was counted. Accordingly, all residences that were located on either side of all street segments of the street intersection to which the residence of interest was closest to were also counted. The results in Table 5 show that the number of residences along either side of a street segment ranges from a minimum of two to a maximum count of 29 residences. If the number of residences along the street segments with a common intersection are counted then the minimum number is 15, the maximum is 58. Both minimum and maximum numbers include the street address where a homicide victim resided.

The question that needs to be addressed now is: What is the minimum number of all residences, including the residence of interest, so that the privacy of an individual residing at this address is not compromised? For this research the confidentiality rules used by the U.S. Census Bureau of how to protect the privacy of individuals is followed. Title 13 United States Code, Section 9, prohibits the Census Bureau from publishing results in which an individual's or business' data can be identified. The U.S. Census Bureau uses different disclosure limitation procedures to protect the confidentiality of data, including suppression, data swapping and protection of micro data files (see <http://factfinder.census.gov>). Among the methods used by the Census Bureau, suppression is directly applicable within the context of this research. The U.S. Census Bureau defines suppression as "a method of disclosure limitation used to protect individuals' confidentiality by not showing (suppressing) the cell values in tables of aggregate data for cases where only a few individuals or businesses are represented." For example, cell values for up to three individuals or businesses were suppressed, but a cell value of seven was not. Accordingly, the U.S. Census Bureau must use a cut-off value for data suppression that lies somewhere between four and six.

If the same guidelines from the U.S. Census Bureau were applied to this research then four of the fourteen residences (#3, #6, #8 and #9 from Table 5) for the masking method 'aggregating incident locations at the midpoint of its street segment' would have been suppressed. In other words, such geographically masked locations should not be displayed in a map,

"... to what extent one might be able to identify an individual incident location after this location has been geographically masked."

Confidential location of individual residences, numbered consecutively	Number of residences on either side of the street segment containing the confidential location	Number of residences on either side of all street segments with a common intersection. One of these street segments includes the confidential location
1	22	50
2	29	52
3	4	20
4	12	29
5	9	17
6	2	25
7	28	54
8	6	18
9	2	24
10	9	15
11	25	26
12	27	58
13	24	34
14	29	34
TOTAL	228	456
MEAN	16.3	32.6
MINIMUM	2	15
MAXIMUM	29	58

Table 5. Comparing the number of residential buildings along one street segment or along all street segments with a common intersection. The location of one of the residential buildings is confident.

because the privacy of individuals living at these residences would not be guaranteed. In cases like this, one solution would be to display each of these four residence locations at their closest intersection. By doing so the confidentiality of the individuals living at these residences would be protected.

IX. Summary

This research suggests that an appropriate masking method is one that combines the two strategies of aggregating confidential incident locations at either 'the midpoint of their street segment' or 'at their closest street intersection'. More specifically, the first strategy should be applied when a total of seven or more incident locations ('background population') that also includes the confidential location(s), can be counted on either side of the street segment. When that number falls below seven, confidential incident locations should be aggregated to their closest street intersection. Seven is the cut-off value for data suppression used by the U.S. Census Bureau to protect the confidentiality of its published data.

Based on the above discussion, the following general guidelines for geographically masking any location that contains confidential data are proposed. These guidelines lay the groundwork for the development of mapping and/or GIS modules that enable confidential data to be appropriately masked before released to the public.

"This research suggests that an appropriate masking method is one that combines the two strategies of aggregating confidential incident locations at either 'the midpoint of their street segment' or 'at their closest street intersection'."

1. Aggregate each confidential location (the address of a residence) to the midpoint of its street segment.
2. Count the number of all residences (addresses) on either side of the street segment that also included the confidential location. This count defines the 'background population' and includes the confidential location.
3. For street segments where this count is less than seven, move the confidential location from the midpoint of its street segment to its closest intersection. If seven or more residences are counted on either side of the street segment, do not move the confidential location.

NOTES ¹The Mann-Whitney U test is the nonparametric equivalent to the t test and tests whether two independent samples are from the same population. It requires an ordinal level of measurement. U is the number of times a value in the first group precedes a value in the second group, when values are sorted in ascending order (SPSS Inc., 2001).

²The Kruskal-Wallis H test is the nonparametric equivalent to the one-way ANOVA. It tests whether several independent samples are from the same population and requires an ordinal level of measurement (SPSS Inc., 2001).

ACKNOWLEDGEMENTS

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Civil War Topographical Engineering in the Shenandoah

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This study advances knowledge concerning military topographical engineering in the Shenandoah Valley of Virginia during 1861 and 1862 operations. It examines representative historical maps, Union and Confederate official reports, the wartime journals of James W. Abert, Jedediah Hotchkiss, and David Hunter Strother, and a detailed post-war reminiscence by Thomas H. Williamson to illuminate the typical experience of the topographical engineer in early war operations in the Shenandoah. Evidence indicates that Civil War topographers mostly performed the tasks one would expect of them: mapmaking, reconnaissance, and orienteering. They were occasionally required to perform other duties tailored to their individual talents. There is evidence that the role of Confederate topographical engineers was more specific than that of Union officers.

Keywords: topographical engineering; American Civil War; Thomas J. "Stonewall" Jackson; Jedediah Hotchkiss; James W. Abert; David Hunter Strother; Thomas H. Williamson; Franz Kappner; historical cartography; military cartography; Corps of Engineers—history.

INTRODUCTION

“... no previous studies of Shenandoah mapping . . . investigate the work of other army topographers contemporary with Hotchkiss. Furthermore, the literature has generally ignored the fundamental question of how . . . armies utilized their topographical engineers . . .”

The cartographic and historio-geographical literature concerning 19th century topographic engineering during the Civil War in the Shenandoah Valley is reasonably extensive, but has exclusively concentrated on the life and work of Jedediah Hotchkiss, Lt. Gen. Thomas “Stonewall” Jackson’s chief topographical engineer. Historians have generally held that the quality of topographic information supplied to Jackson by Hotchkiss (and his *Map of the Shenandoah Valley*) was so superior to that available to Union forces during the 1862 campaign as to constitute a serious tactical advantage fundamental to Jackson’s success in that theater. Further discussion of Hotchkiss’s contribution to Jackson’s success can be found in Krick (1996), Miller (1994a; 1994b; 1993), Nelson (1992), and McElfresh (1999). Specific details about Hotchkiss’s service in 1861 and 1862 as well as later in the war and during Reconstruction, are readily obtained from a variety of sources including Craig (1965), Hotchkiss (1973), McElfresh (1999), Miller (1994a; 1994b; 1993), and Stephenson (1999). In contrast there are no previous studies of Shenandoah mapping that investigate the work of other army topographers contemporary with Hotchkiss.

Furthermore, the literature has generally ignored the fundamental question of how Union and Confederate armies utilized their topographical engineers during the war’s early phases. The Corps of Topographical Engineers was charged with gathering terrain intelligence and conveying this to commanders through maps. Regular army engineers were primarily intended to supervise the construction of roads, bridges, fortifications, and campsites. The Confederacy had no separate topographical corps (Nichols, 1957) and the Union disbanded theirs in 1863 (Traas, 1993) on the assumption that officers from both the Corps of Topographi-

cal Engineers and the Corps of Engineers generally performed the same mix of obligations and thus did not function as separate corps. This assumption has never been tested.

This study addresses these deficiencies first by identifying three Union topographers who mapped the Valley of Virginia during 1861 and 1862 operations: Cpt. James W. Abert, Maj. Franz Kappner, and Cpt. David Hunter Strother. It also identifies Confederate Col. Thomas H. Williamson, an officer who served as topographical engineer for Jackson for a few weeks in early May 1862, but who is not known to have produced any maps. No previous study has associated these topographers with Civil War mapping in the Shenandoah. Representative maps by the Union topographers are qualitatively compared to a sample of Hotchkiss's work.

Next, the paper examines various contemporary sources to ascertain the customary duties of topographical engineers operating in the 1861 and 1862 Shenandoah Valley campaigns. This is presented through analysis of information from Union and Confederate official reports, as well as from the posthumously published journals of Hotchkiss (1973) and Strother (1961), the unpublished military journal of Abert (1861), and the unpublished memoir of Williamson (1883). Observed duties for these topographers are arrayed in a task matrix to quantify their relative balance of responsibilities. From this data it is possible to infer that—contrary to the expectations of the U. S. Army in 1863—topographical engineers in the Shenandoah Valley performed mostly the reconnaissance, mapping, orienteering, and general staff service details for which army topographers were intended in 19th century warfare.

Sample Civil War Maps of the Shenandoah

Most important, of course, to the history of topographical engineering in the Valley of Virginia in 1861 and 1862 is the cartographic record of the army topographers themselves. This study examines maps by Abert, Strother, Hotchkiss, and Kappner.

Figure 1 shows the area of operations during the Shenandoah Valley campaign. The Shenandoah River system is digitized from U. S. Geological Survey 7.5' topographic quadrangles.

Abert's Cartography

The Shenandoah campaign's Cpt. James W. Abert was an experienced topographical engineer who graduated from the U. S. Military Academy in 1842. His father, John James Abert, was head of the Topographical Bureau from 1829 until the 1838 formation of the separate Corps of Topographical Engineers, which he led until his retirement in 1861. During the 1840s, the younger Abert was assigned to various trigonometric, geodetic, and military surveys of the Great Lakes and throughout the southwest. His duties included independent command of important New Mexico (Abert, 1847) and west Texas (Abert, 1846) surveys, as well as subordinate roles in John C. Frémont's California and Great Basin surveys. He served with Cpt. William H. Emory during the Mexican War, and afterwards when that officer directed the joint boundary survey in accordance with provisions of the Treaty of Guadalupe Hidalgo. Although there is no published biography of Abert, scattered sketches and accounts of his western expeditions can be found in the following sources: Carroll (1941a; 1941b), Galvin (1966; 1970), Morris (1999), Ronda (2003, p 48-52, 55), Tyler (1996, p 7-8), and peppered throughout Goetzmann (1959).

"No previous study has associated these topographers with Civil War mapping in the Shenandoah."

". . . contrary to the expectations of the U. S. Army in 1863—topographical engineers . . . performed mostly the . . . details for which army topographers were intended in 19th century warfare."

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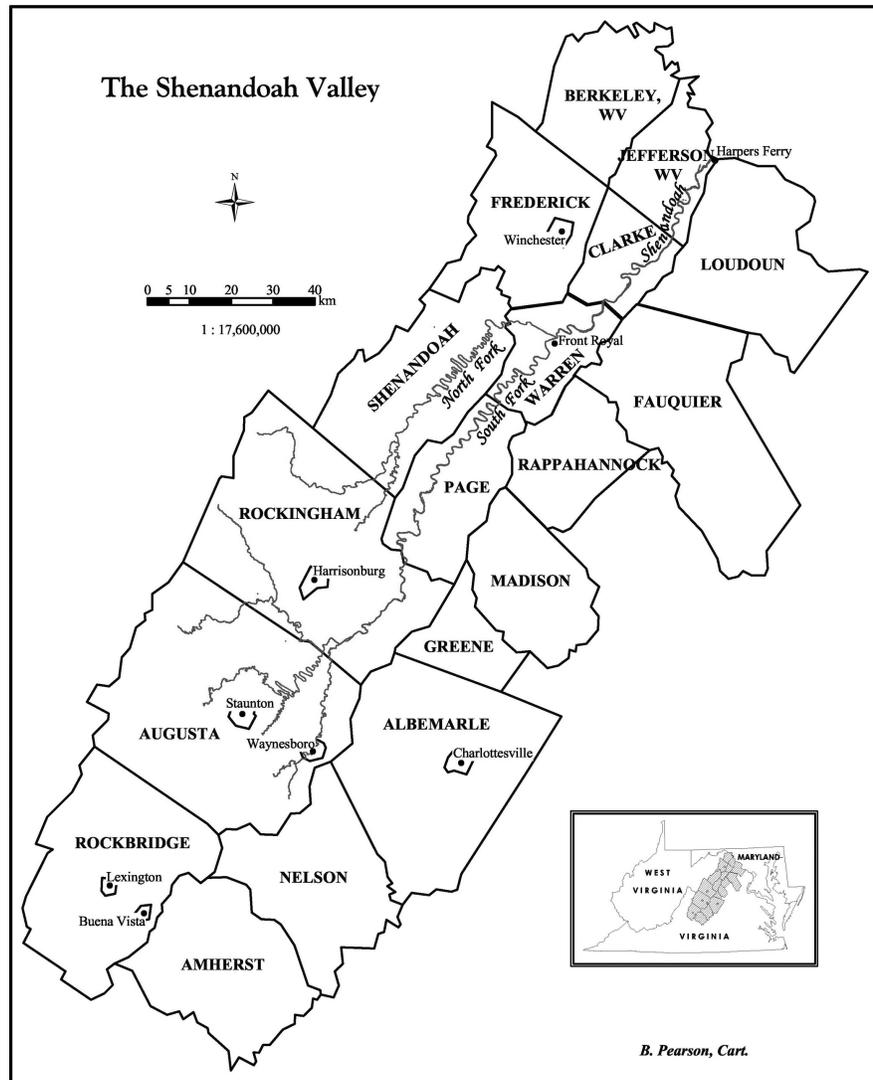


Figure 1. Map showing the theater of operations for the 1861 & 1862 Shenandoah Valley campaigns. The river system is from U.S. Geological Survey 7.5' topographic quadrangles. (See page 84 for full-size color version)

“During the summer of 1861, Abert produced for Maj. Gen. Nathaniel Banks a fine triangulation survey of the Shenandoah River.”

During the summer of 1861, Abert produced for Maj. Gen. Nathaniel Banks a fine triangulation survey of the Shenandoah River. The carefully executed manuscript *Map of the Shenandoah River from Harper's Ferry to Port Republic* is housed at the National Archives as RG77: Z116. Figure 2 reproduces this 32 x 135 cm work. Although primarily intended to be a survey of the river itself, details such as tributaries, mills and dams, and selected place names facilitate the broader application of this data. The inset to Figure 2 demonstrates Abert's fine draftsmanship as well as the triangulation grid on which the map's features were registered.

Although Abert approved several extant maps of the Shenandoah Valley (see National Archives RG77: G463-9, RG77: G463-11, and RG77: G463-19), the only other surviving map from the period attributable to Abert's cartography is an untitled map of the area northeast of Strasburg (National Archives RG77: G463-12). The map is signed by Abert who lists his title as “Capt. U. S. Army, T. Engrs.”—apparently wishing to stress that he was a regular army officer and not merely a volunteer in Banks's army. The scale of this 22.5 x 33.2 cm manuscript map (Figure 3) is shown through a scale bar which converts to 1:126,720. The map

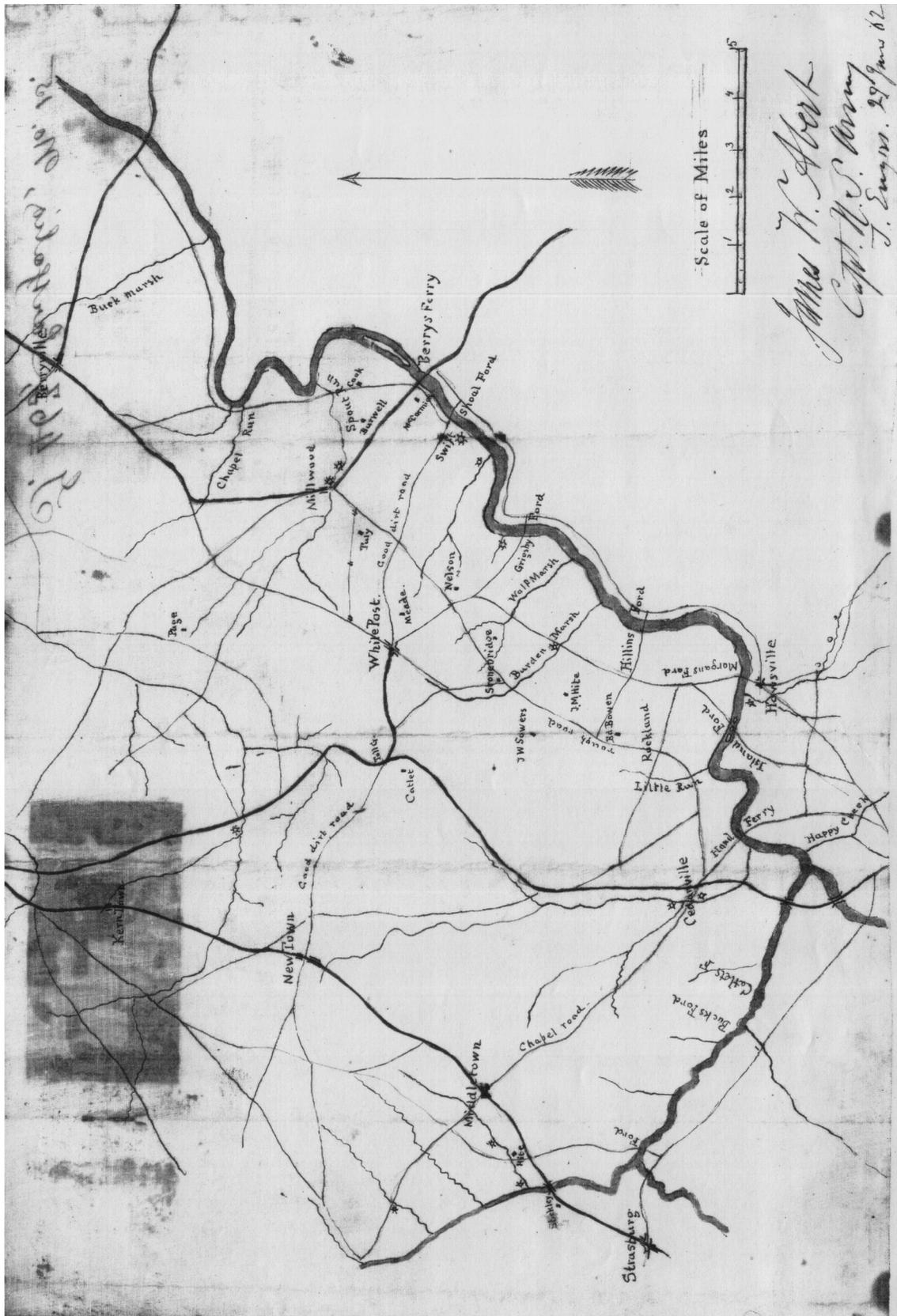


Figure 3. Abert's Map of the Vicinity of Liberty Mills. Source: National Archives RG77: G463-12.

emphasizes the transportation and hydrology networks, although place names and individual property holders' names are also provided. The names and conditions of some roads and fords are noted. Given the map's June 29, 1862 date, it was most likely made to assist in the general shift of Banks's forces eastward around the time of preparations for Maj. Gen. John Pope's 2nd Manassas campaign.

Kappner's Cartography

An examination of relevant maps at the Library of Congress (hereafter LOC) and the National Archives suggests a second Union topographical engineer was active during 1861 and 1862 operations in the Shenandoah Valley: Maj. Franz Kappner. As indicated by text on several maps (see National Archives RG77: G122½, RG77: G206, and LOC CW461), Kappner served as chief topographer for Maj. Gen. Franz Sigel's 1st Corps, Army of the Potomac. By inference from information on a twenty-nine map series (LOC CW304) portraying forts around St. Louis, one can presume that Kappner was transferred to Missouri before the maps' July 18, 1864 submission date. This study was unable to locate additional information about Kappner's life and career. Since one of Sigel's greatest contributions to the Union war effort was his popularity as a recruiter among German-Americans, the fact that one of his staff officers had a German name is not necessarily instructive. However, the skill with which his maps were executed and their apparent accuracy indicate that Kappner was a trained topographical engineer. It is therefore possible that Kappner had served with Sigel during the latter's unsuccessful military coup in Germany during the 1840s.

Figure 4 reproduces Kappner's *Map of the Valley of Virginia* now housed at the National Archives as RG77: Z403½. The 51.5 x 40 cm map is marked with a regular grid oriented to the cardinal directions. Relief is shown through hachures in this map of the Shenandoah's drainage between the Blue Ridge and the Cumberland Plateau. The North and South Forks, as well as the Shenandoah itself are shown in their entirety. The map also identifies cities and towns in addition to the regional transportation network. Although not embellished with color, the work is otherwise a rather refined general reference map of the Shenandoah Valley which would have been quite suitable for the strategic needs of Sigel's corps.

Strother's Cartography

David Hunter Strother was well known on the advent of the Civil War. His highly popular writings and illustrations were featured in *Harper's New Monthly Magazine* during the 1850s under the penname, *Porte Crayon*. Born in Martinsburg, Virginia (now West Virginia), Strother enjoyed the upbringing of the Southern gentry of his day. As a young adult he studied art under John Gadsby Chapman, the author of the leading drawing primer of the mid-nineteenth century and painter of one of the works in the U. S. Capitol building Rotunda. He also studied under Samuel F. B. Morse at New York University. Most notable today for helping popularize the telegraph through the development of Morse Code, in the 1830s Morse was among America's most celebrated painters. During the 1840s Strother developed a critically praised talent for woodblock printmaking, which skill he combined with a playful, graceful prose to produce his illustrated local color travel narratives serialized in *Harper's*. Details about Strother's life and work are available in Eby (1960) and Cuthbert and Poesch (1997).

"Kappner served as chief topographer for Maj. Gen. Franz Sigel's 1st Corps, Army of the Potomac."

"David Hunter Strother was well known on the advent of the Civil War. His highly popular writings and illustrations were featured in Harper's New Monthly Magazine during the 1850s under the penname, Porte Crayon."

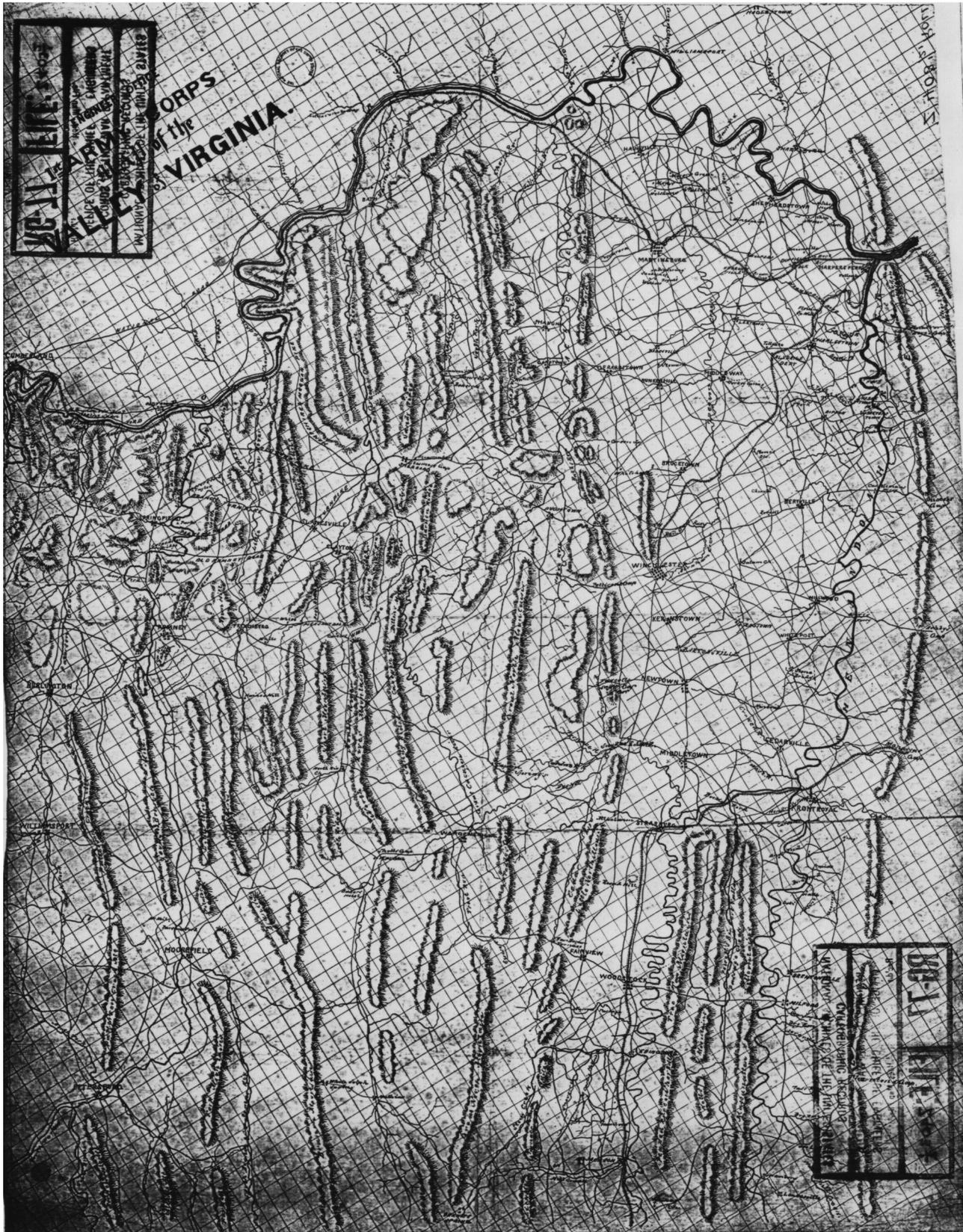


Figure 4. Kappner's Valley of Virginia. Source: National Archives RG77: Z403 1/2.

With the onset of civil war, Strother was like many western Virginians in maintaining a staunch unionist stance. The most dominant factor encouraging this was his complete confidence that the industrial and numerical superiority of the Free States were insurmountable and predicated the North's total victory in the Civil War (Strother, 1961; Strother Collection). Strother joined the Union army on July 9, 1861 following the assassination of his father by local secessionists. During 1861 and 1862 operations in the Shenandoah, Cpt. Strother served alongside Abert on Banks's staff.

The only example of Strother's cartography during the Shenandoah Valley campaign is his 1862 *Topographic Sketch of the Vicinity of Liberty Mills*, which is reproduced as Figure 5. The work clearly demonstrates Strother's cartographic skills. The 23.4 x 14.4 cm pen and ink manuscript map employs two colors and the progressive (for the 1860s) use of contour lines and inkwash shading instead of hachures to represent elevation. The stated scale is 1:7,200. Rivers and roads are named, as are the owners of some properties. Also noted are the destinations to where roads lead, as well as travel distances to those places. The map is augmented by commentary on the construction and condition of the mill, bridge, and ford. Given Strother's training and experience as a successful professional illustrator, it is not surprising that his wartime mapmaking was highly attractive.

Hotchkiss's Cartography

Without question Jedediah Hotchkiss is the most famous personality among Civil War topographical engineers. Scholarly fascination with Hotchkiss has been facilitated by the breadth and quality of his collection of maps and journals from the war, most of which are now deposited at the Library of Congress. The collection is outlined in LeGear (1977) and Stephenson (1989), while the tale of how it came to the LOC is recounted in Roper (1989). The Hotchkiss literature itself has already been introduced.

Hotchkiss was born in Windsor, New York and migrated to the Shenandoah Valley when he was nineteen. During the 1840s and 1850s Hotchkiss served as a schoolmaster until he and his brother, Nelson, opened Loch Willow Academy near Staunton in 1859. During the 1850s Hotchkiss also ran a successful surveying and mapping firm in Staunton.

Hotchkiss officially entered the service of Virginia in March 1862 when he joined state forces as adjutant to Lt. Col. W. S. H. Baylor's regiment with the rank of captain (Hotchkiss, 1973). When Virginia subsequently transferred its troops to Confederate service, commissions were nullified until Richmond could ensure officer merit. It was during this restructuring of the Army of the Valley's order of battle that Jackson took note of Hotchkiss and detailed him to be his chief topographical engineer. This took him out of the cycle for automatic commission in the Confederate States Army. The war's most celebrated topographical engineer thus remained a civilian throughout the conflict, although notable personages from both sides customarily referred to him after the war as "Captain" or "Major" Hotchkiss. The matter of Hotchkiss's illusive commission is discussed in Hotchkiss (1973), and is treated rather decidedly in McDonald (1967).

A civilian employee in the Confederate service, Hotchkiss received a heady charge as his first task as Jackson's topographer: to make a map of the entire Shenandoah Valley. Receiving his commission from Jackson to make the map on March 26, 1862, Hotchkiss diligently commenced

"... Strother was like many western Virginians in maintaining a staunch unionist stance."

"Without question Jedediah Hotchkiss is the most famous personality among Civil War topographical engineers."

"The war's most celebrated topographical engineer thus remained a civilian throughout the conflict..."

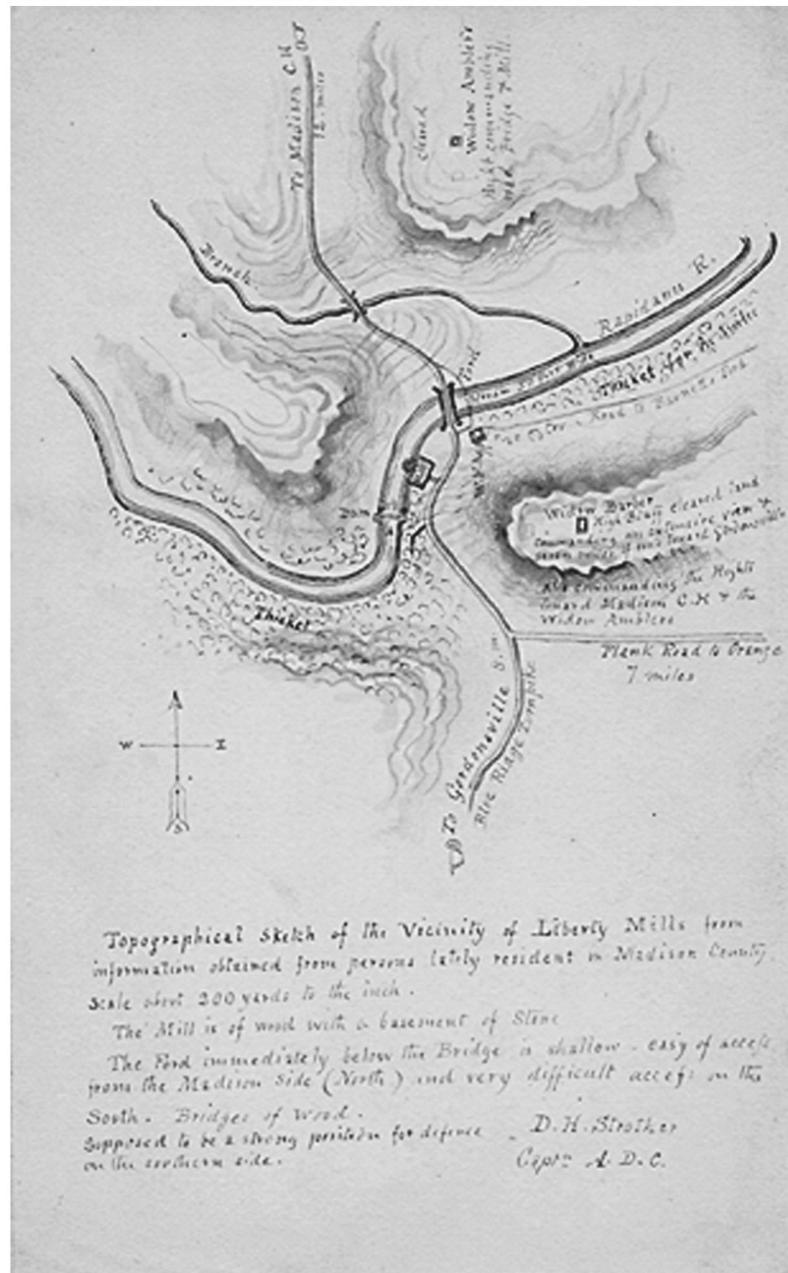


Figure 5. Strother's Topographical Sketch of the Vicinity of Liberty Mills. Source: West Virginia and Regional History Collection. (See page 85 for full-size color version)

work the following morning and then devoted most of his time to it until mid-April (Hotchkiss, 1973). His journal fails to state precisely when the 254 x 111 cm masterpiece was presented to Jackson, but it is obvious that the LOC copy (H89) was never completed. The northern quarter of the Shenandoah River is entirely absent as are most details for the region between Winchester and the Potomac. Because of the map's size, it is not possible here to reproduce effectively Hotchkiss's *Map of the Shenandoah Valley*. However, Figure 6 shows details which illustrate the incomplete sections (such as Inset A from around Winchester) and the completed sections (such as Inset B from around Harrisonburg). The transportation network is red while water features appear in blue. Elevation is shown through contours while populated places are often enhanced with the

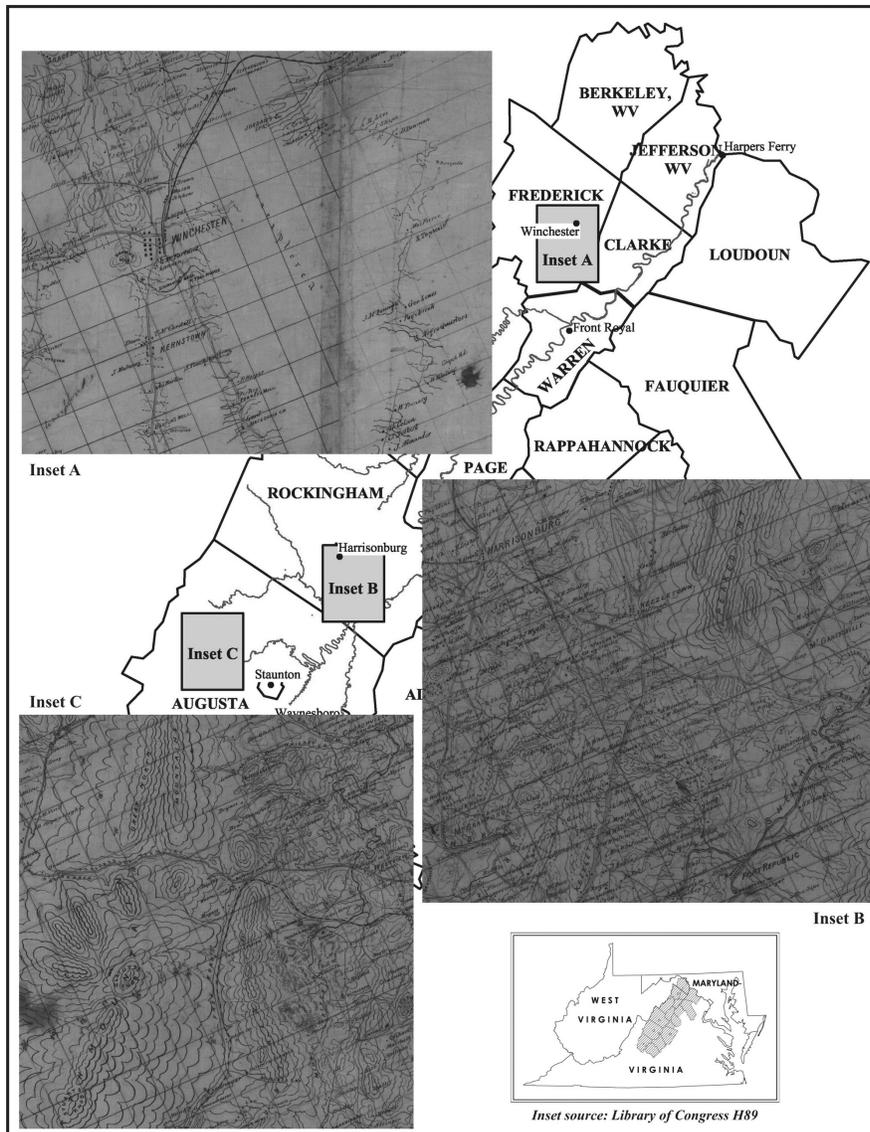


Figure 6. Details from Hotchkiss's Map of the Shenandoah Valley. (See page 86 for full-size color version)

names of individual property owners. Even with its omissions in certain areas, Hotchkiss's 1:80,000 Valley Map is nevertheless impressive and would admirably serve the topographical needs of Jackson during the 1862 campaign.

To provide a more effective parallel to the large-scale sketch maps introduced from Abert and Strother, Figure 7 reproduces Hotchkiss's untitled wartime sketch of the McDowell battlefield (LOC H94). Drawn on tracing paper, the 23 x 31 cm map is monochrome and represents the region at a scale of approximately 1:31,680 (Stephenson, 1989). The map shows roads, drainage, and elevation using hachures. Named features include the village of McDowell, three watercourses, and three local prominences. The residence of R. Sellington is also identified. It is not known whether this map served Jackson's tactical planning needs for the battle or whether it was produced after the action. For the purposes of this study, it will be assumed to have been prepared for the tactical reconnaissance undertaken

“Even with its omissions in certain areas, Hotchkiss’s 1:80,000 Valley Map is nevertheless impressive and would admirably serve the topographical needs of Jackson . . .”



Figure 7. Hotchkiss's Sketch of the McDowell Battlefield. Source: Library of Congress H94. (See page 87 for full-size color version)

by Hotchkiss and Williamson prior to the battle [see Hotchkiss (1973) and Williamson (1883)].

Discussion of Sample Maps

Surviving maps of the Shenandoah produced by these cartographers demonstrate their relative merits. Strother's small sketch map is an effective and attractive example of field cartography. The sketch maps of Abert and Hotchkiss presented by this study also represent effective mapping of field reconnaissance, and were well-suited to facilitate the maneuvers of Civil War armies.

Overall, Hotchkiss's *Map of the Shenandoah Valley* is the best among those examined by this study, if not for its execution, then certainly for its ambitious conception. Nevertheless, the map remains unfinished. Hotchkiss's map is the only one examined which was likely intended to be a presentation quality piece, as the other maps—with the possible exception of Kappner's—were either drafts or sketches. Whereas Hotchkiss's map was specifically commissioned by the army commander, Kappner's map shows a cartographic economy indicative of a map intended for general distribution, and hence, intended to serve the more generalized topographic needs of an army in the field. Abert's Shenandoah River survey rivals the work of Hotchkiss with regard to the precision of its drafting. In short, the maps produced by these four topographic engineers are similar in terms of their cartographic qualities.

Abert's river survey, Kappner's map, and Hotchkiss's Valley map all represent substantial portions of the Shenandoah river system (Abert's

"In short, the maps produced by these four topographic engineers are similar in terms of their cartographic qualities."

map lacks the North Fork, while Hotchkiss's is missing the Shenandoah itself). Figure 8 compares the relative merits of these topographical engineers' work, assembled from digitized manuscript maps from both the National Archives and LOC, overlaid with current U. S. Geological Survey topographic data. These layers were then registered to UTM coordinates.

Positional and representational accuracy is overall best for the Hotchkiss and Kappner maps. In many places along the channel, Abert's map is generalized to the point of barely resembling the river system as shown by current USGS information. Furthermore, Abert seriously mislocates the

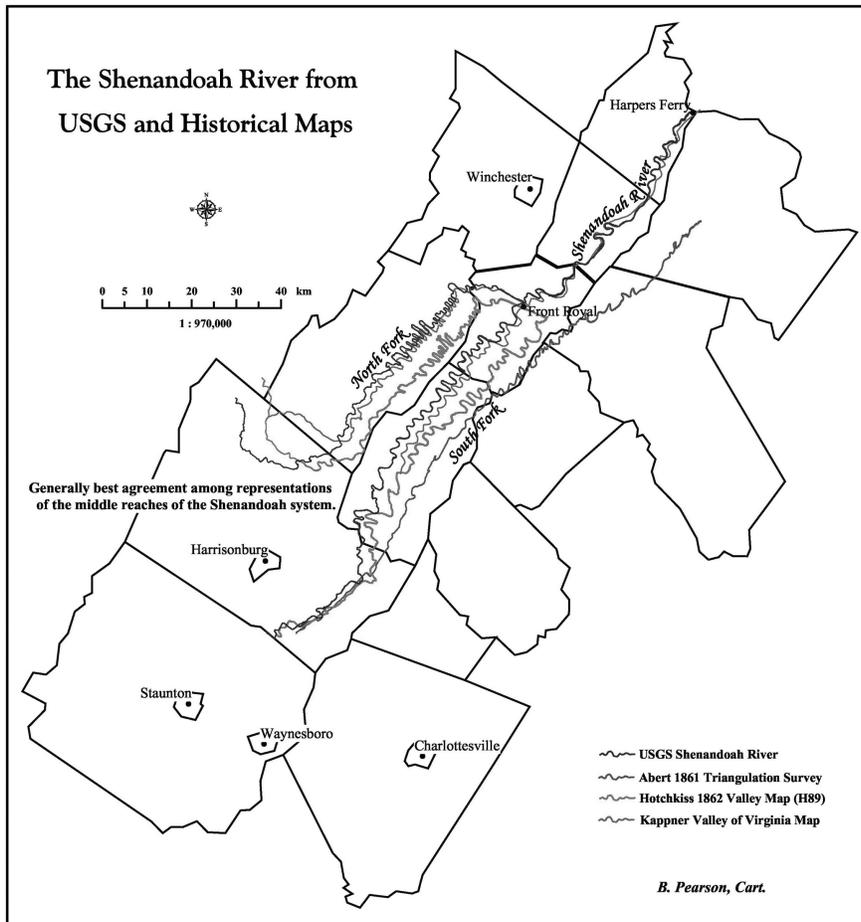


Figure 8. Map showing the Shenandoah river system as represented on historical maps by Abert, Hotchkiss, and Kappner, and in current U.S. Geological Survey data. (See page 88 for full-size color version)

mouth of the Shenandoah River which should have its junction with the Potomac at Harper's Ferry, instead of somewhere in the midst of Loudon County, Virginia. Kappner's map demonstrates the greatest positional and representational precision among the study maps, although Hotchkiss's map is also reasonably accurate for the needs of Civil War armies. In sum, this study has established that other topographers were also producing useful, high-quality maps to support 1861 and 1862 operations in the Valley of Virginia.

"Kappner's map demonstrates the greatest positional and representational precision among the study maps . . ."

The Official Record of Topographical Engineering

Although Civil War topographical engineers in the Shenandoah obviously undertook cartographic duties, it is unclear whether these activities were

predominate among their responsibilities. This section examines official records for each army to determine the information about topographer's activities that were available to headquarters, and to assess how commanders in the theater perceived the responsibilities of their topographical engineers.

Official Union Records

"Official Union reports of action in western Virginia in 1861 and 1862 are almost entirely silent in reference to topographic activities."

Official Union reports of action in western Virginia in 1861 and 1862 are almost entirely silent in reference to topographic activities. Abert is the only topographical engineer whose activities are mentioned in any official report from the three Union commanders facing Jackson in the Shenandoah. The unofficial documentation is silent on topographic activities as well. For example, the diary of Col. Albert Tracy (1962a; 1962b), Maj. Gen. John C. Frémont's Adjutant during the Shenandoah Valley campaign, contains no reference to topographical engineers. There is no reference in the account to Tracy's superior consulting maps or the advice of topographical officers for any sort of terrain intelligence to support the maneuvers of his army. This apparent lack of interest in topographical engineering gives credibility to the assertion that Union armies in the Shenandoah Valley in 1861 and 1862 were negligent in their efforts to take tactical advantage of terrain.

The "Report of Maj. Gen. McClellan on Army of Potomac Operations July 27, 1861 – Nov. 9, 1862" (Scott 1881 Series 1, Vol. V, Ch. 14, hereafter referred to as *OR* after the series' common name "Official Records") is perhaps the most concise and precise description from Union high command of the topographical engineer's role in supporting an army in the field. To students of 1862 Shenandoah Valley operations this report is important because it outlines McClellan's organizational structure and operational concepts, which he encouraged subordinates to adopt throughout his command that included all forces important to Union operations throughout northern and western Virginia in late 1861 and 1862.

"McClellan states that . . . 'the corps of topographical engineers was entrusted the collection of topographical information and the preparation of campaign maps' . . ."

McClellan states that, primarily, "the corps of topographical engineers was entrusted the collection of topographical information and the preparation of campaign maps" (*OR* Series 1, Vol. V, Ch. 14, p. 25) necessary to army operations. This task was not simple since "Owing to the entire absence of reliable topographical maps the labors of this corps were difficult and arduous in the extreme" (*OR* Series 1, Vol. V, Ch. 14, p. 25). In his report, McClellan acknowledges that topographers frequently had to gather necessary information under fire. Overall McClellan's general tone toward topographical service is quite positive, demonstrating admiration of his topographical engineers' abilities to accomplish so much in spite of various obstacles.

McClellan's official report underscores a salient characteristic of topographic engineering in the Union army during the Civil War: that cartography and its requisite data collection were but a component of the actual service required of topographic corps officers in the wartime army. Speaking specifically of the Peninsula Campaign, McClellan declares that

"it was impossible to draw a distinct line of demarcation between the duties of the two corps of engineers, so that the duties of reconnaissance of roads, of lines of entrenchments, of fields for battle, and the position of the enemy [traditional responsibilities for topographical engineers] as well as the construction of siege and defensive works [traditional engineer corps duties] were habitually performed by de-

tails from either corps, as the convenience of the service demanded" (*OR Series 1, Vol. V, Ch. 14, p. 25*).

This perception of a de facto blending of the two corps in the field led to their ultimate merger on March 3, 1863. This is anticipated in McClellan's report when he mentions that he united the two corps to good effect when he reorganized the Army of the Potomac in preparation for the Antietam campaign.

Official records contain a report of Abert's experiences on May 24, 1862 which effectively illustrates the multifaceted duties of the Civil War topographical engineer to which McClellan's report alludes. Upon orders from Banks, that morning Abert led a company of Zouaves to a bridge over Cedar Creek in readiness to burn it. Arriving at the bridge, Abert had the soldiers gather "a tar-barrel, some straw, some commissary pork, and other inflammable materials" from a nearby barn and tender a fire so that the bridge could be razed immediately upon receipt of the appropriate signal from Banks (*OR Series 1, Vol. XII, Part 1, p. 568*). Abert waited until 3:30 pm, when he withdrew, bridge intact, because the ford beneath the bridge "was in much better condition than the bridge" (*OR Series 1, Vol. XII, Part 1, p. 568*).

Arriving at Middletown (see Figure 3) Abert's force encountered Confederates whom they dispersed after a brisk engagement. A few miles south of Middletown, Abert encountered a friendly artillery battery with whom they fought off more Confederates in another skirmish. The group withdrew to Strasburg at which point Abert decided to dash for Winchester despite the array of Rebels between him and that destination. The artillery captain decided to retire his battery separately. Ultimately, Abert prudently avoided Winchester and led his men on a three day circuitous route to Williamsport, Maryland, and thus to safety.

One can infer from official reports and pronouncements that the Union topographical engineer faced a varied routine. This staff officer was called upon to provide maps or other topographical information as required by his commanding officer. These duties frequently entailed field reconnaissance under fire. Since the Corps of Topographical Engineers was an officer-only organization (Traas 1993), laborers and escorts had to be impressed from friendly units. Sometimes the topographical engineer was required directly to engage the enemy. The Union topographical engineer could expect to perform Corps of Engineers tasks as well.

It is also evident that the Union official records indicate that the Corps of Engineers and the Corps of Topographical Engineers bore duties that were frequently blurred in practical service. This paper will later examine the wartime journals of Abert and Strother to determine whether the observed duties of U. S. army topographers support this assertion.

Confederate Official Records

Confederate Records lack any direct statements from high command as to the duties required of topographical engineers. This is true for both *OR* and for the Confederate Engineering Department records at the National Archives. However, official Southern records during this period mention the services of topographical engineers more frequently than do Northern records.

Ironically, Hotchkiss does not appear in Jackson's April 14, 1863 official "Report of Valley Operations May 14-June 17, 1862" (*OR Series 1, Vol. XII, Part 1*). But he does warrant mention twice in Jackson's April 14, 1863 "Report of Port Republic Battle" (*OR Series 1, Vol. XII, Part 1*)—once for

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" . . . Union official records indicate that the Corps of Engineers and the Corps of Topographical Engineers bore duties that were frequently blurred in practical service."

"Confederate Records lack any direct statements from high command as to the duties required of topographical engineers."

“Confederate topographical engineers operating in the Valley of Virginia in 1861 and 1862 undertook many different responsibilities . . .”

“The wartime journals of Abert, Hotchkiss, and Strother as well as a detailed postwar reminiscence by Williamson . . . clarify understanding of the responsibilities of topographers in the Civil War . . .”

“ . . . Abert served on the staff of Maj. Gen. Nathaniel Banks as his head topographical engineer.”

his efforts to guide reinforcements through a forest to assail Union artillery batteries at the Coaling above the battlefield, and again for his cartography. Two examples of Hotchkiss’s cartographic work were also included in Jackson’s report. Postwar lithographs of both maps appear in the *Atlas to Accompany the Official Records of the Union and Confederate Armies* (Davis, 1983).

The activities of topographical engineers are also prominent in the report of Army of the Valley Chief Engineer, Cpt. James K. Boswell whose “Report of Operations June 1-9, 1862” (OR Series 1, Vol. XII, Part 1, No. 61) was submitted to the War Department in Richmond on March 27, 1863. Hotchkiss figures prominently in the Chief Engineer’s description of activities around the close of the Valley Campaign. In Boswell’s report, both Hotchkiss and his assistant Sgt. Brown are credited with (1) transmitting orders in the field, (2) successfully wrangling wagons on the march, (3) reconnaissance and signal operations, (4) leading troops to their battle stations, and (5) bridge-burning activities. Interestingly, Boswell’s report fails to mention his topographical engineers undertaking any mapmaking.

In sum, as with the Union army, Confederate topographical engineers operating in the Valley of Virginia in 1861 and 1862 undertook many different responsibilities when they accompanied the army in the field. These responsibilities extended beyond map drafting tasks to other wayfinding and reconnaissance tasks. Only in burning a bridge are Hotchkiss and Brown seen to act outside the customary duties of topographical engineers.

Evidence of Topographer’s Duties from Documentary Sources

Although the evidence from Union and Confederate official records is instructive, it does not constitute the definitive record of topographic engineering in the Valley of Virginia. The wartime journals of Abert, Hotchkiss, and Strother as well as a detailed postwar reminiscence by Williamson also serve to clarify understanding of the responsibilities of topographers in the Civil War Shenandoah. Each of these sources was examined to determine the relative burden of each topographical engineer’s time occupied by the various tasks he was asked to perform. By counting the number of days each task was undertaken, it is possible to calculate the fraction of days each topographer engaged each task. Results appear in the task matrix in Table 1.

Abert’s Military Journal

During 1861 and 1862 operations in the Shenandoah Valley, Abert served on the staff of Maj. Gen. Nathaniel Banks as his head topographical engineer. Between July 1, 1861 and August 31, 1861, Abert kept a military journal now housed at the Filson Historical Society as part of the Abert Collection (MSS A.A991). The journal is a leather-bound notebook of a generally legible script with daily entries in pen. In some places the text has been edited to correct the spelling of names, or to clarify an illegible word. Although Abert offers no explanation for keeping the journal, his systematic composition was most likely inspired by the long-standing Corps of Topographical Engineers’ requirement that its officers keep journals. This practice was useful during the exploration of the frontier since details about landform, flora, and fauna could help natural scientists and policy makers assess the relative merits of unknown areas. Journal keeping was suspended when the Corps of Topographical Engineers was subordinated to the Corps of Engineers in 1863 (Traas, 1993).

Relative Burden of Different Tasks on Shenandoah Topographical Engineers

task	Union						Confederate					
	Abert <i>July 1 to Aug. 31, 1861</i>		Strother <i>Feb. 27 to June 28, 1862</i>		Hotchkiss <i>Mar. 26 to July 15, 1862</i>		Williamson <i>Apr. 30 to May 15, 1862</i>					
	days	fraction of all	days	fraction of all	days	fraction of all	days	fraction of all	days	fraction of all	days	fraction of all
reconnaissance	11	17.7%	14	11.5%	19	17.0%	7	43.8%				
mapmaking	15	24.2%	9	7.4%	47	42.0%	n/a	n/a				
general staff service	15	24.2%	15	12.3%	2	1.8%	1	6.3%				
guiding troops / trains to destination	8	12.9%	5	4.1%	7	6.3%	1	6.3%				
furlough	7	11.3%	13	10.7%	3	2.7%	n/a	n/a				
bridging / fording	5	8.1%	2	1.6%	6	5.4%	n/a	n/a				
provost service	3	4.8%	5	4.1%	n/a	n/a	n/a	n/a				
camp selection and management	4	6.5%	n/a	n/a	1	0.9%	n/a	n/a				
leading troops actively engaged	3	4.8%	1	0.8%	n/a	n/a	1	6.3%				
working with spies	n/a	n/a	11	9.0%	n/a	n/a	n/a	n/a				
interrogating prisoners	n/a	n/a	10	8.2%	n/a	n/a	n/a	n/a				
fortifications engineering	4	6.5%	n/a	n/a	n/a	n/a	n/a	n/a				
sick	n/a	n/a	6	4.9%	n/a	n/a	n/a	n/a				
burn bridge / obstruct road or pass	n/a	n/a	n/a	n/a	3	2.7%	n/a	n/a				
drill troops	1	1.6%	n/a	n/a	n/a	n/a	n/a	n/a				
translate military textbook	1	1.6%	n/a	n/a	n/a	n/a	n/a	n/a				
		n = 62		n = 122		n = 112		n = 16				

Table 1.

“ . . . Abert’s wartime journal was examined to determine the relative burden of his time occupied by the various tasks he was asked to perform.”

“ . . . the overwhelming majority of Abert’s time was spent in typical Corps of Topographical Engineers activities.”

“Abert’s duties . . . were not limited to topographical engineering.”

Most entries in the journal detail Abert’s official duties. He provides lengthy accounts of experiences dining in the homes of Shenandoah locals. Since these encounters frequently involved heated arguments with secessionist hosts, Abert probably considered this noteworthy intelligence. Details of other leisure activities were also recorded, but when Abert tells of vacationing with his family in New York, he does so with more economy.

For the purpose of this study Abert’s wartime journal was examined to determine the relative burden of his time occupied by the various tasks he was asked to perform. From this it is possible to determine the number of days Abert performed the various tasks required of him, and to determine the fraction of days he undertook each task. The results of this investigation appear in Table 1.

During the summer 1861 campaign, the overwhelming majority of Abert’s time was spent in typical Corps of Topographical Engineers activities. When his time actually drafting maps is combined with his reconnaissance, it becomes clear that Abert spent around 42% of his task days engaged by these basic cartographic activities. During this period Banks’ troops were frequently repositioned in the Valley in skittish response to localized Confederate aggression. It is therefore not surprising that Abert frequently (13% of days) had to guide troops or wagon trains to their destinations, since this was part of army topographers’ orienteering obligations. Abert’s general staff service (24.2% of task days) was expected of him because topographers belonged to an officer-only Corps attached to headquarters. Altogether, traditional topographical officer duties accounted for 79% of Abert’s task days.

Abert’s duties, though, were not limited to topographical engineering. For example, approximately 8% of Abert’s task days saw some sort of fording or bridge duty. Fortifications engineering as well as camp selection and management each occupied him for 6.5% of his days. These tasks were traditionally the responsibility of officers of the Corps of Engineers, and together constituted 21.5% of Abert’s days.

For nearly 5% of his task days Abert performed provost duties. In the Civil War army the provost department served a function similar to military police today. Provost officers were generally drawn from among the regular infantry, not from a highly specialized corps. Another standard infantry duty which Abert performed was the drilling of troops. This is most likely indicative of the general shortage of veteran officers available to help train and organize recruits in the war’s early days. The most unusual service Abert performed was his translation of a brief French military textbook for Banks.

Strother’s Military Journal

For most of his adult life David Hunter Strother wrote copiously in daily journals. Besides serving a normal diary function, Strother also used his journals like an artist’s sketchbook to serve as studies for his stories. This is seen in the intimate parallel between events in Strother’s Civil War journal, and those in Porte Crayon’s “Personal Reflections on the War” which was serialized in *Harper’s Monthly* between 1866 and 1868. Strother’s twelve volume wartime journal details his activities almost daily, from July 11, 1861 to October 15, 1864. These volumes are described in Eby (1961) and are available at the West Virginia and Regional History Collection in Morgantown.

Strother’s (1961) wartime journal was edited such that there are omissions from the original, although Eby (1961) stresses that he omitted

only frivolous details unrelated to the war, or to Strother's service in it. A careful examination of Strother's diary manuscript verifies Eby's assertion since the entries he omitted reveal no information relevant to Strother's duties as a topographical engineer.

Strother's active service with Banks in the Shenandoah Valley ran from February 27, 1862 until June 28, 1862 when the topographer was called to Washington to make maps for Maj. Gen. John Pope to support the 2nd Manassas movement. To determine the relative burden of various duties on Strother's time, his journal (Strother, 1961) was examined for these 122 days. Table 1 provides the results of this investigation.

Overall Strother's duties during the Shenandoah Valley campaign were somewhat different from Abert's. Among individual tasks, general staff service was required of Strother most frequently (12.3% of task days). Nearly 19% of Strother's days involved specifically cartographic duties such as mapmaking and reconnaissance. Provost related duties accounted for over 21% of Strother's task days, including over 17% of which involved interrogating prisoners and working with spies. He was either sick or on furlough almost 16% of observed days. Other activities occupied Strother much less frequently.

Traditional duties of topographical engineers—reconnaissance, mapmaking, orienteering, and general staff service—dominated Strother's obligations, accounting for 27% of his task days. Strother seldom performed traditional Corps of Engineers details, which accounted for only 1.6% of his task days.

Strother's extensive involvement in provost duties is singular. While Abert also performed some provost duties during the same period, they constituted a much smaller fraction of his time. For Strother provost duties—especially work with prisoners—were the most frequent category of activity he was required to perform. Most likely Banks entrusted so much intelligence gathering activities to Strother because of his personal celebrity in, and familiarity with, the Shenandoah region. Strother's connections with local unionists made him well-suited to work with spies. Likewise, Strother's situation as a national celebrity could have encouraged prisoners to be more forthcoming when he interrogated them. Whatever the reason, Banks certainly expected Strother to work with spies and to interrogate prisoners far more frequently than was common for topographical engineers.

Hotchkiss's Field Journal

To quantify the burden that each responsibility had on Hotchkiss's time, the topographer's journal (Hotchkiss, 1973) was examined to determine the number of days he was required to perform the various tasks he mentions undertaking over the 112 days between March 26, 1862 and July 15, 1862. These dates cover the period of Hotchkiss's involvement with activities related to the 1862 Shenandoah Valley Campaign, starting with his receipt of the commission from Jackson to "make me a map of the Valley from Harper's Ferry to Lexington" (Hotchkiss 1973, p. 10) and ending when he reunited with Jackson's command for the 2nd Manassas Campaign against Pope. Table 1 provides the results of this investigation.

Hotchkiss's diary indicates that almost 67% of his task days during the Valley Campaign were typical of topographical engineering. Almost 60% of his days involved some sort of cartographic enterprise, either directly drafting maps or performing surveys and reconnaissance. Hotchkiss engaged orienteering duties 6.3% of task days during the campaign. General staff service was undertaken fairly rarely (1.8% of task days).

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"... Banks certainly expected Strother to work with spies and to interrogate prisoners far more frequently than was common for topographical engineers."

Traditional engineering responsibilities occupied comparatively little of Hotchkiss's time, approximately 9% of his task days. Hotchkiss was on furlough for three days (2.7%). He undertook no other type of task during the period of observation.

The evidence presented here suggests that the typical order executed by Hotchkiss either was directly related to mapmaking, involved some sort of reconnaissance, or entailed orienteering troops or material to their destinations. All these are typical responsibilities of military topographical engineers. Occasionally Hotchkiss was called upon to perform other services, but these were almost wholly within the domain of martial engineering. Hotchkiss's service was less diverse than that of the other study topographical engineers, especially his limited role in general staff service. This condition probably resulted from Hotchkiss's civilian status which limited the manner in which he could be employed by Jackson, although evidence presented below from Williamson's memoir might indicate that Jackson defined his staff's responsibilities more narrowly than did Banks.

"Hotchkiss's service was less diverse than that of the other study topographical engineers . . ."

Thomas H. Williamson's Wartime Reminiscence

Unlike the other topographical engineers entertained by this study, there is no published information about the life of Thomas H. Williamson. The Virginia Military Institute (VMI) archives contain a wealth of materials concerning Williamson, but these seem as yet not to have been systematically examined by scholars. The biographical information here is derived from materials in both the Thomas H. Williamson and the William G. Williamson archives at VMI.

Williamson was born on either August 13 or August 30, 1813 to a banker and the daughter of an influential Norfolk family. He attended the U. S. Military Academy for four years but did not graduate, dropping out in his last term to become a civil engineer. After working at the Naval Yard in Norfolk, Williamson supervised the James and Kanawha Canal and directed various Corps of Engineers projects throughout Virginia. In 1841 he joined the faculty at VMI as a professor of drawing, geology, engineering, and architecture. Except for temporary diversions during the Civil War, Williamson performed these duties at VMI until his death in 1888.

At the beginning of the Civil War, Williamson received a commission of Lt. Colonel of Engineers in state forces. He planned and supervised the construction of the field works at Manassas and Centreville, Virginia, some of which were used in the war's first major battle. In October 1861, most VMI faculty were ordered back to Lexington to resume training future Confederate officers. Otherwise Williamson ventured to active service during the Civil War only briefly during Jackson's 1862 Valley Campaign, during the Battle of New Market when VMI cadets gallantly faced Union forces, and during the spirited but futile attempts to defend VMI from David Hunter's torch in 1864.

Diary evidence of the type previously examined is not available for Williamson's topographic service, but in 1883 Williamson wrote a detailed account of his service with Jackson during the 1862 Shenandoah Valley Campaign. Williamson's "My Service with Genl. Thos. J. Jackson" is organized diary style, a daily account of the colonel's time working with his former VMI colleague from April 30 to May 15, 1862, around the time of the Battle of McDowell. Williamson's service with Jackson's army at that time is corroborated by orders preserved in the Thomas H. Williamson Collection at VMI as well as by Hotchkiss's journal.

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"He planned and supervised the construction of the field works at Manassas and Centreville, Virginia, some of which were used in the war's first major battle."

Williamson served on Jackson's staff for only sixteen days and he appears to have been recruited specifically to support operations leading up to the McDowell engagement. Thus, the scope of his actions was necessarily more limited than that of the other topographical engineers discussed in this study for whom longer records are available. As Table 1 indicates, Williamson performed only four types of tasks: reconnaissance, general staff service, guiding troops or trains to their destination, and leading troops actively engaged with the enemy. Of these responsibilities, Williamson was most commonly asked to provide reconnaissance, which he did approximately 44% of the days he was on Jackson's staff. This and other traditional topographer's tasks accounted for 56% of Williamson's task days. The only other activity Williamson performed was to lead troops against the enemy.

All the topographical engineers examined by this study except Hotchkiss at one time or another found themselves leading troops who were engaged by hostile fire. Williamson's experience leading troops under fire was rather different from those of Abert and Strother since his assignment from Jackson anticipated encountering enemy forces. Abert and Strother led troops under fire only when they and their escorts were attacked while performing a non-combat detail.

On May 8, 1862 at the start of the Battle of McDowell, Williamson was ordered by "Genl Jackson to accompany a body of infantry and to feel the enemy on the right of the road and Genl [Bushrod] Johnson did the same thing on the left" (Williamson 1883). The act of "feeling" an enemy in Civil War parlance meant to vigorously engage the enemy's forward skirmishers with the intent of pushing their skirmish line back to the main lines either in preparation for a full-scale attack or to determine the opponent's strength or general readiness to fight. Although there was a reconnaissance function involved, when an enemy was "felt" prior to a planned assault, it was generally considered an infantry obligation. It was most unusual for Williamson to have been asked to lead such a detachment. This probably illustrates Jackson's familiarity with Williamson from their time together on the VMI faculty and indicates he knew he could trust Williamson with this important assignment.

Discussion of Findings

This study has introduced the cartography of four topographical engineers operating in the Shenandoah in 1861 and 1862: Abert, Hotchkiss, Kappner, and Strother. Only the work of Hotchkiss has been examined by previous studies. The cartographic output of these army topographers is qualitatively rather similar. All produced attractive maps useful and appropriate to their purpose. Positional and representational accuracy was examined for the following historical maps: Abert's *Map of the Shenandoah River from Harper's Ferry to Port Republic*, Kappner's *Map of the Valley of Virginia*, and Hotchkiss's *Map of the Shenandoah Valley*. It was determined that Kappner's map displayed the greatest degree of positional accuracy to current USGS information about the form and location of the Shenandoah river system.

Through this investigation it has become obvious that topographical engineers besides Hotchkiss were active in the Civil War Shenandoah and that those individuals produced high quality cartography to support their armies' operations. There is thus no reason to presume that the terrain intelligence of the Valley of Virginia available to Jackson was inherently superior to that available to Union commanders in the region.

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". . . Williamson was most commonly asked to provide reconnaissance . . ."

". . . Kappner's map displayed the greatest degree of positional accuracy to current USGS information about the form and location of the Shenandoah river system."

“... the army’s 1863 decision to dismantle the independent Corps of Topographical Engineers was based on the faulty assumption that the Corps’ service was undifferentiated from that of standard army engineers.”

This study examined the duties typical of Union and Confederate topographical engineers serving in 1861 and 1862 operations in the Valley of Virginia. This was accomplished through investigations of Union and Confederate official records and the wartime journals of Abert, Strother, and Hotchkiss as well as the postwar memoir of Williamson. These four individuals were responsible for much of the mapping and terrain intelligence available to commanders during 1861 and 1862 operations in the Shenandoah Valley. Two of these topographical engineers, Abert and Williamson, had extensive military experience prior to the war. All but Abert were typical of many professional class volunteers of the early war.

As previously introduced, McClellan maintained that topographical engineers were primarily “entrusted [with] the collection of topographical information and the preparation of campaign maps” (OR Series 1, Vol. V, Ch. 14, p 25). Evidence examined by this study confirms that this description of the duties of topographical engineers is generally accurate for both armies. Terrain intelligence activities (reconnaissance, mapmaking, orienteering, and general staff service) were decidedly predominate among the tasks topographers were expected to perform during 1861 and 1862 operations in the Valley of Virginia. Topographical duties occupied over 50% of task days for all except Strother.

The evidence examined by this study contradicts McClellan’s assertion that “it was impossible to draw a distinct line of demarcation between the duties of the two corps of engineers” (OR Series 1, Vol. V, Ch. 14, p. 25). For all topographical engineers examined by this study, with the exception of Abert, Corps of Engineers duties occupied a trivial amount of their time. Even Abert spent only one-fourth as much time on engineering details as on his topographic duties, so his assignment to them was also comparatively minor. From this analysis it is clear that topographical engineers in the Civil War Shenandoah predominately performed assignments normally associated with topographical engineering. The evidence therefore indicates that the army’s 1863 decision to dismantle the independent Corps of Topographical Engineers was based on the faulty assumption that the Corps’ service was undifferentiated from that of standard army engineers.

The evidence presented in this study also indicates that there was a tendency for topographers’ assignments to be tailored to their individual expertise. For example, Banks frequently used Strother to interrogate prisoners and to work with spies, a reflection of his native knowledge of the Valley and his family’s extensive connections with important unionists throughout the region. These duties and regular provost service accounted for 21% of Strother’s task days, comparable to Abert’s diversion to engineering details. Abert was likewise required to drill troops and to translate a French military textbook into English, tasks indicative of his long service in the prewar army and of his West Point education. Most likely his engineering responsibilities reflected his training and experience, and the value of these skills to a volunteer army in hostile territory.

“... there was a tendency for topographers’ assignments to be tailored to their individual expertise.”

This tendency to employ topographical engineers according to their merits is more difficult to assess for the Confederate army. Hotchkiss and Williamson performed a less diverse service than did Abert and Strother. This difference between Union and Confederate engineers could be the result of data compatibility issues introduced by the very short record for Williamson and by Hotchkiss’s lack of a commission. It is possible that Hotchkiss and Williamson both were perceived to have talents confined generally to topographical engineering. It is also quite possible that Jackson defined the role of his topographical engineers more narrowly than did Banks. Although further investigation would be necessary to confirm

and clarify it, evidence from this study indicates that the two armies employed their topographical engineers somewhat differently, at least in terms of the balance of responsibilities placed upon them. In general, Union topographers are seen to have undertaken a greater variety of tasks beyond traditional topographical engineering than was common for Confederates.

Conclusion and Directions for Further Study

There is evidence to suggest that the duties of Confederate topographical engineers were more narrowly defined than those of their Union counterparts. Contrary to expectations from McClellan's report and from the 1863 restructuring, army topographers in the Valley of Virginia from both sides commonly undertook those tasks most generally associated with Civil War topographical engineering: mapmaking, field reconnaissance, general staff service, and guiding troops or wagon trains to their destinations. Contrary to existing literature about Civil War mapping of the Shenandoah, Jedediah Hotchkiss was but one of several individuals who provided effective terrain intelligence to both Union and Confederate armies in the theater.

This study uncovers several questions for further investigation. Were topographical engineers in the Shenandoah region employed in the same way later in the war? Furthermore, it would be useful to examine the activities of topographical engineers operating in other theaters for a comparison of the employment responsibilities of these officers. As there has been little research completed on the collection and use of terrain intelligence by Civil War armies, there are many opportunities to significantly advance scholarly understanding in this field.

"... Union topographers are seen to have undertaken a greater variety of tasks beyond traditional topographical engineering than was common for Confederates."

"... Jedediah Hotchkiss was but one of several individuals who provided effective terrain intelligence to both Union and Confederate armies in the theater."

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cartographic techniques

Working With Your Printer

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Introduction

The printing industry has experienced significant changes over the years. In an industry where key lines, paste-ups, rubyliths and overlays were once everyday fare, the introduction of electronics has changed the methods used to prepare jobs to be printed in all phases of production, namely pre-press, printing, and finishing. While printing presses and finishing equipment have improved over the years, the actual steps used to get the job ready for press have changed dramatically.

There are several necessary steps or decision making areas required to successfully print the maps and literature designed by cartographers today. This article is divided into sections that deal with each of these areas.

Proofing

Proofing and reviewing of your files is an essential part of the printing process and by taking care to do it properly, you can save significant time and expense. As your job is readied for press, i.e., before the printing plates are made, this is your last chance to review every detail from content to color.

There are several proofing methods available today. One important item to note is that all proofs are a simulation of how the final map will look. In particular,

the paper you choose to proof your map with may not, in some cases, be able accurately represent certain colors of ink. To help you choose the best proofing method for your map, here are three and their pros and cons.

Kodak Approval Proofs

Kodak Approval proofs are considered the best predictor of colors from proof to the printed sheet. This is a dot proof, meaning it will have the same dot pattern and line screen as the printed job. Approval proofs also can be used to check trapping and all content. Some printers have the Kodak Approval XP Recipe Color proofer. This device allows the printer to simulate most of the PMS (Pantone) colors including metallic colors. The one limitation of this proofing method is its size is limited to approximately 20" x 24". For larger maps, the printer may either tile several proofs together to reach the correct size of the map, or a reduced-size proof can be made for review. While more expensive, this proof may well be worth the investment:

Digital Inkjet Proofing Device Proofs

Digital inkjet proofs can be a good alternative to a Kodak Approval proof, and inkjets offer most of the same benefits. There are several high quality digital inkjet proofers available today from manufacturers like Epson, HP, Canon, etc. These devices are very good predictors of color, however, while most cannot show the actual dot pattern and line screen used for printing, they can be used for checking color, trapping, and content. One big advantage to this type of proofing device is the ability to make large proofs. Most devices are only limited to their maximum width but can go as long as needed. Therefore, proofs as large as 60' wide are possible.

Another important consideration is their relative cost is about one half the cost of a Kodak Approval proof.

Inkjet Printing Proofs

Standard inkjet printers produce a lower resolution proof that can be used only for checking content and as a final folding "dummy" of the map. This type of proof should never be used to make decisions about color, as they are not an accurate predictor of how color will look on the printed sheet.

Printing

After final proofs have been reviewed for color trapping and content, it is time to make the printing plates. A simple rule of thumb to remember about the cost of printing is, the closer you get to the final end product the more costly a change will be. One way to think of this is that at the time the cartographer is building the electronic file, it is simple to make a change to the map. If, however, a change is needed or a problem is discovered when you're on-press, a number of steps need to happen to fix the problem:

1. The cartographer will need to make the changes to the file.
2. The pre-press department will need to update the printing files.
3. New proofs must be reviewed.
4. New printing plates will have to be made.

So, it can be very expensive to make a change once printing begins. This just re-emphasizes the point of needing to be careful and thorough in reviewing proofs.

If possible, you should be present at the time of printing. This is a great time for you to learn more about the various printing process-

es and you can use that knowledge to your benefit when creating new maps in the future.

When attending a “press check”, there are some best-practices checks to follow in reviewing the first off-press sheets:

1. First, check all content and double check any last minute changes.
2. Then start to review the colors. Usually some variances between proof and the printed sheet will occur. This is normal, as proofs are designed to *simulate* color. But they should look like the proofs you have approved. If not, tell the printer what you see. Though it will be tempting, try not to tell the printer which colors to adjust. Rather, indicate the printer the job looks too “bluish” or too “greenish” or whatever it is you see that you don’t like. It is the printer’s responsibility to know which of the four process colors need adjusting to address your concerns.
3. Check for a row of small color squares across the edge of the printed sheet. These are color control bars used by printers to monitor and control color consistency throughout the run. Most good quality printers use them not only to control color but also as a means of recording the values that can be used for reruns. If these bars are not present, ask the printer why.

Folding

The final stage in producing your maps is trimming and folding. Good planning is critical when laying out maps. Work backwards. What is the desired final folded size? What needs to appear on the

outside front and outside back panels? Is there advertising space within the map? Where are the ads to be placed?

These things can be very difficult to envision, so use a folding dummy from your printer made to the actual size of the map. Getting the printer involved in the early planning stages can save a lot of problems and surprises later on in the production processes.

Accordion folding is the most common type of fold for maps. It is the most efficient and the least stressful on the paper. Also, it is the easiest for the map-reader to use, allowing them to review sections of the map without unfolding the whole map. Special folding configurations can be done, but check with your printer first. If special folding equipment is needed, but is not available, publication costs can be increased significantly.

Papers

Choosing the type of paper or synthetic material to use can be challenging. Is a material that is water, chemical or tear resistant necessary? Consider how the map will be used, who will be using it, under what conditions, and how much wear and tear will it endure? Is it a road map living in a glove compartment to be used by the casual traveler? Or will a hiker be pulling it out of their backpack to refer to it while traversing the trails through Yellowstone National Park?

The types of papers commonly used are broken down into three categories: *Offset Uncoated* paper, *Gloss Text* paper and *Synthetic Materials*. This by no means covers all of the available choices; it is only meant to create some awareness of each, and what the characteristics of each are.

Offset uncoated

Offset uncoated paper is the most common paper used for maps. It is relatively inexpensive and is the least durable of the papers in this discussion. Offset uncoated papers will absorb the inks resulting in softer and more subdued colors on the printed sheet. If the map being published has a short life cycle, or if you are building in planned obsolescence, this might be the correct paper for your map.

Gloss text

Gloss text papers are a very common alternative to offset uncoated papers. Gloss text provides good color matching to the proofs. The colors will appear bright and rich and should closely resemble your Approval or Digital Inkjet proofs. Because of the coating this paper will be a little more durable than uncoated offset papers. Gloss text papers are only about 15-20 percent more expensive than uncoated offset papers.

Synthetic materials

Synthetic materials provide greater strength and durability, including some with water, chemical and tear resistance. Most will print much like gloss text and will show color much like the proofs. Hop-Syn, Polyart, and Tyvek are a few of the more popular synthetic materials used today.

The relative cost of synthetic materials can vary greatly. Some can be as much as ten times more expensive than uncoated offset papers. If a synthetic material is desired, work with a printer who has experience printing onto synthetic materials. Special inks, trimming, scoring and folding requirements might be needed depending on which synthetic material you’re interested in using.

Conclusions

By choosing an attentive printer and actively participating in the print process you will learn how to effectively plan successful printing projects. This article covered the basic areas that require your attention and described the places in the printing process where you can gain valuable experience by working closely with your printer. Printing maps is ideally a partnership between skilled map makers and printers; and when you are in such a partnership with your printer success in your projects is almost guaranteed.

map library bulletin board

Building a Digital Collection of Photos and Maps: *Milwaukee Neighborhoods at the University of Wisconsin-Milwaukee Libraries*

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Introduction

Milwaukee Neighborhoods: Photos and Maps 1885 – 1992 was created at the University of Wisconsin-Milwaukee Libraries (UWM Libraries) as a result of cooperation between the Libraries staff and the faculty at the Department of Geography. The goal of the digitization project was to gather unique material from the Librar-

ies' collections featuring Milwaukee neighborhoods, convert it into a digital format, and present it as an online resource to students, faculty, and the general public. The digital collection, available at <http://www.uwm.edu/Library/digilib/Milwaukee/index.html>, provides a visual documentation of the development of Milwaukee neighborhoods.

Drawn from several source collections at the American Geographical Society Library and the Archives Department at the UWM Libraries, the project includes 638 photographs and 12 historical maps of Milwaukee. The maps and images were scanned and integrated into an online system through indexing and descriptive metadata. An extensive research process accompanied digitization to provide not only a consistent description of all images, but also additional access points for image discovery. Following the collection release in March 2004, an evaluation study was conducted to examine user behavior in the resource discovery process and to assess user satisfaction with the collection.

This paper will report on the collaborative nature of the digitization project and will provide an overview of the process of building the collection including selection, scanning, research and indexing, and design of the online collection. It will also explore the usefulness of the collection from the faculty perspective.

Cooperation with Faculty

UWM Libraries initiated a digitization program in the fall of 2001 to take advantage of the rapidly evolving imaging and communications technologies and to share unique resources from the Libraries' holdings with a wide audience. Expanded access and reduced handling of fragile archival materials were recognized as primary

benefits of digitization (Smith, 1999). In addition to the Archives and Special Collections, the UWM Libraries house the American Geographical Society Library with its extensive map and photographic collections.

While work on the pilot digitization project was being completed in 2002, the Libraries staff began to informally survey the faculty on the campus about their interest in digital collections and use of visual resources for research and instruction. Two digital projects resulted from this initial inquiry: *Transportation Around the World: 1911 – 1993* (<http://www.uwm.edu/Library/digilib/transport/index.html>); and *Milwaukee Neighborhoods: Photos and Maps*, the topic of this article. When Geography Professor Judith Kenny suggested the second project, the proposal received the immediate approval and support of the Libraries staff. Based on discussions with faculty members, reference inquiries, and library instruction sessions, the demand for such a digital collection appeared quite obvious. Currently, architecture, geography, and history students among others regularly require materials on local topics for class projects. Ironically, students often find it more difficult to locate images or maps of local areas than of distant cities or countries. Although a few students visit archives or special collections, increasingly they turn to the Web as a primary source of information. According to Steve Jones's study on the impact of the Internet on college students "nearly three-quarters (73%) of college students say they use the Internet more than the library, while only 9% said they use the library more than the Internet for information searching" (2002). Digitization has offered libraries an unprecedented opportunity to meet the students in the space of their choice and reach a wider audience.

Digitization projects benefit from the close partnership with faculty on the campus. As Nancy A. Van House points out “effective digital library (DL) design is not simply a matter of converting existing information practices and artifacts to a digital world” (2003). It requires multiple players and “collaborative knowledge construction” (Van House, 2003). Cooperation with faculty allows academic libraries to identify areas of interest and to build useful and applicable collections that will support instruction and scholarly work. Faculty contributes invaluable subject expertise and a direct connection to users and to the academic curriculum, while librarians bring knowledge of source collections, expertise in digital library standards and practices, and skills in information organization.

When Professor Kenny suggested this theme for the project, she envisioned a collection that would be used regularly by her students and herself for illustrative and research purposes. With a visually oriented general population, she saw the digital collection as an impressive means of immediately “bringing” various areas of Milwaukee to the classroom and thus introducing students to neighborhoods that they might not otherwise have visited. Historical photos provide an opportunity to challenge students’ “taken-for-granted” notions of urban life by showing familiar scenes under past conditions. Students in more advanced urban geography classes are required to consider the changing character of Milwaukee’s neighborhoods for class projects. With easily accessible photographs and maps, their understanding of the changing landscape is enlivened and they have tools for gathering information about their project areas. Finally, Professor Kenny recognized the tremendous resource that the

photographic and map collection represents for community members and researchers beyond the Milwaukee campus. She hoped to share this resource and in this way to encourage research on the city as well as more general topics such as housing, industrial development and change, or the photographic and cartographic images themselves.

Beyond recommending the project, Professor Kenny’s contribution to the project included consulting on the indexing fields for the collection, and preparing an article “Picturing Milwaukee Neighborhoods” for the site. The article, available at <http://www.uwm.edu/Library/digilib/Milwaukee/records/picture.html>, presents a historical perspective on the development of neighborhoods in Milwaukee that will acquaint community members and introductory students with basic information on the city’s growth.

Source Collections and Selection

The images and maps for the *Milwaukee Neighborhoods* project were selected from several source collections of the American Geographical Society Library and the Archives Department. The collections featuring Milwaukee neighborhoods were identified in the planning phase of the project. The digitization project allowed one to gather materials from the collections scattered throughout different departments in the Libraries. Bringing together images from disperse collections resulted in a heterogeneous project where one can correlate and compare images of the same site or building and examine them side by side (see Figure 1, Figure 2, and

Figure 3).

The photos of Milwaukee from the end of the 19th century come from two rare books in the Archives’ holdings: *Milwaukee* and *Art Work of Milwaukee*. The first book, *Milwaukee*, consisting of 98 plates, does not have a title page, therefore the publication date or the name of the publisher cannot be determined. Research of the scanned images, however, indicates that most of the photographs were taken around 1885. The two volumes of *Art Work of Milwaukee* were published in 1895 in Chicago by W.H. Parish Publishing Co. The plates provide images of Milwaukee’s first neighborhoods, Juneau Town, Kilbourn Town and Walker’s Point, and demonstrate a strong German influence on the development of the city.

The images of Milwaukee in the 20th century were selected from two photographic collections: the Roman Kwasniewski Collection, housed at the Archives, and the Harold Mayer Collection, located in the American Geographical Society Library. Roman Kwasniewski was a professional photographer, who in addition to thousands of wedding and first communion pictures also took photos of businesses and urban scenes on the Milwaukee South Side. Many of the photographs were taken at the



Figure 1. Milwaukee River, Downtown, 1895. Source collection: Art Work of Milwaukee.



Figure 2. Milwaukee River, Downtown, 1989. Source collection: Harold Mayer Collection.



Figure 3. Milwaukee River, Downtown, 1898. Fragment of Wright's Map of Milwaukee, published by A.G. Wright, Milwaukee, 1898.

request of local businesses, real estate, and insurance companies, and include images of store grand openings, parades, churches, movie theaters, new housing, car accidents, and floods. They vividly document the life of the primarily Polish-American com-

munity on the Milwaukee South Side between 1910 and 1940.

The Harold Mayer Collection provides a more comprehensive coverage of Milwaukee neighborhoods with images of public housing developments, parks, and industrial facilities throughout the

city. Harold Mayer was a professor of geography at the University of Wisconsin-Milwaukee. He specialized in the Urban and Transport Geography of North America with a focus on New York, Chicago, Milwaukee, and British Columbia. Of the approximately 50,000 slides in the Harold Mayer Collection, 217 color slides were selected for the *Milwaukee Neighborhoods* project. These images show Milwaukee in the years 1948 - 1992.

12 maps of Milwaukee from the holdings of the American Geographical Society Library accompany the image collection. The maps illustrate the growth and development of the city from 1883 to 2000. They were published by a variety of publishers, including Alfred G. Wright, city directory publisher. Most of the maps selected for the digital collections are in the public domain. For the maps published after 1923, the Libraries staff negotiated with the companies holding copyright for permission to post the map images on the collection Web site. Several map publishers granted permission to include the maps in the digital collection without charge.

The selection of images is limited by the current boundaries of the city of Milwaukee, as defined in the 2000 Milwaukee Neighborhoods Map created by the Department of City Development Information Center. An attempt was made to represent all neighborhoods within the boundaries of the city of Milwaukee. The coverage, however, is not even. A few neighborhoods, such as the Near South Side, Downtown, and East Side have a higher number of images due to the concentration of the source photographic collections at the UWM Libraries. The Kwasniewski Photographic Collection is almost entirely devoted to the Milwaukee South Side. There are also images on the Near

South Side in the Harold Mayer Collection. On the other hand, Far Northwest Side, Northwest Side, and Far West Side have a limited representation. The images of these neighborhoods come exclusively from the Harold Mayer Collection. Professor Kenny intends to contribute her slide collection to expand both the neighborhood coverage and extend the dated material in the collection to the present time. With this contribution, it is hoped that other faculty members using the materials will make their collections available as well.

Those images that are part of the current collection represent various aspects of the city's neighborhoods – their historical development, architecture, and community life. The collection presents pictures of industrial facilities, business and commercial enterprises, historic buildings, parks, streets, and residential facilities, including single-family homes, mansions, apartments, condominiums, and public housing developments. There are several photos of Polish flats, a unique Milwaukee housing structure, typical of the Near South Side (Figure 4 and Figure 5). The images depict breweries and tanneries, such as Schlitz, Pabst, and Pfister and Vogel, which once dominated Milwaukee's industrial landscape, and companies that are still in business like Allen-Bradley Company.

Image Capture

Since the project utilizes source materials in a variety of formats, including photographic prints, slides, glass plate negatives, and maps, the conversion process from analog format to digital required versatile scanning equipment. A film scanner Nikon 4000 ED, a large format scanner Colortrac 4280, and two flatbed scanners Microtek ScanMaker E6 and



Figure 4. Polish flat on Milwaukee's South Side, 1933. Source collection: Roman Kwasniewski Photographic Collection.

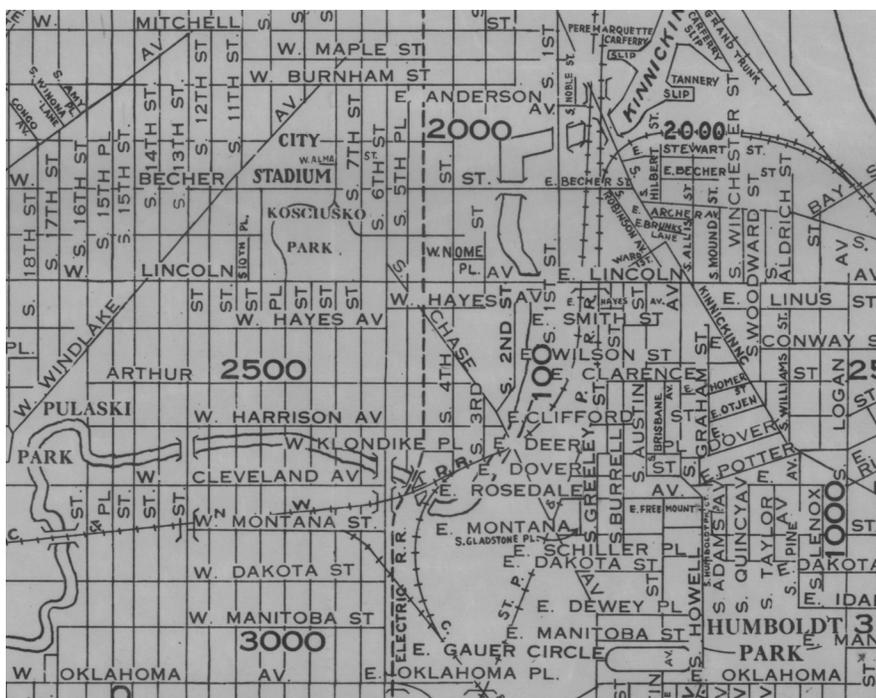


Figure 5. Milwaukee's South Side. Fragment of New Edition Map of City of Milwaukee and Suburbs. Published by Siekert and Baum Stationery Co. and Milwaukee Electric Railway and Light Co., 1934. Copyright by Wisconsin Electric Power Company (We Energies). Used with permission.

Epson Perfection 2400 were used in the scanning process to scan the source materials appropriately to their format. Following a recommendation in the digital library literature images were scanned from the original source items

when possible. Several resources in the field suggest scanning from the earliest generation of the photograph (negative) rather than from intermediaries, such as photographic prints (Frey, 2000; NINCH, 2002). Frey notes, "be-

cause every generation of photographic copying involves some quality loss, using intermediates inherently implies some decrease in quality" (2000). For the *Milwaukee Neighborhoods* project photographic prints were used when the first generation photographs were not available or the negatives were deteriorated.

The photographic prints included in the two monographs *Milwaukee* and *Art Work of Milwaukee* were scanned at 300 ppi resolution using a flatbed scanner Microtek ScanMaker E6. Most of the original prints are 11"x13" or 13"x 11". 300 ppi resolution was sufficient to provide a good quality scan. The RGB (color) mode rather than grayscale was used to capture the aging nature of the print medium and create a faithful reproduction of the original photographic prints.

35 mm color slides in the Harold Mayer Collection were scanned at 4,000 ppi resolution using a Nikon 4000 ED film scanner. The slides were scanned at the highest resolution offered by the scanning software to create high quality master files. As indicated in the *Western States Digital Imaging Best Practices*, "there are compelling preservation, access, and economic reasons for creating an archival-quality digital master image: it provides an information-rich, unedited, research quality surrogate, and ensures rescanning will not be necessary in the future. A high-quality master image will make the investment in the image capture process worthwhile" (Western States Digital Standards Group, 2003).

The same principle was followed in the digitization of images from the Kwasniewski Photographic Collection. The glass plate negatives were scanned at 1,200 ppi or 800 ppi resolution in a grayscale mode using a flatbed scanner Microtek ScanMaker E6 with a transparency adapter. The

original glass negatives are 8"x10" or 5" x 7"; the larger negatives were scanned at 800 ppi, 5" x 7" were scanned at 1,200 ppi resolution. The prints from the Kwasniewski Collection were selected when the glass plate negatives were not available or the quality of the scans from the negatives was poor. The photographic prints were scanned at 600 ppi resolution using Microtek ScanMaker E6 and Epson Perfection 240 flatbed scanners. The prints were scanned in the RGB (color) mode to provide an accurate representation of the original items.

The digital master images were saved as uncompressed TIFF files. The images were edited for contrast, tone, and color balance in Adobe Photoshop. The changes were saved and a second copy of uncompressed TIFF files was produced. Derivative images for Web delivery were created from the master TIFF files. The resolution of derivative files was reduced to 72 ppi and they were saved in JPEG format. The master files in TIFF format are stored at the UWM Libraries and can be used to create a variety of digital derivatives or high-quality prints.

The maps were scanned at 400 ppi resolution using a large format scanner Colortrac 4280. The original scans were saved in TIFF format and then were transferred to the MrSID compression format using ArcGIS software. MrSID, a proprietary format of the LizardTech company, allows one to compress large image files and view them through standard Internet browsers. Users can browse, pan, and zoom into the map files. Viewing the maps requires downloading MrSID viewer (ExpressView Browser Plug-in) from the LizardTech company website at <http://www.lizardtech.com/>. Although the ability to zoom on the map and view detail on the street level is an exciting proposition, an

evaluation study conducted in the spring of 2004 found that users encountered many difficulties in viewing the maps. The need to download the plug-in from an external Web site was identified as a major obstacle. UWM Libraries plans to take advantage of a new open international standard for image compression, JPEG2000 (<http://www.jpeg.org/jpeg2000/>) to replace the map files in MrSID format. CONTENTdm, software suite, which was used to build the online collection, will offer JPEG2000 extension as of August 2004, thus making possible to integrate the maps in JPEG2000 format into the collection. Users will be able to apply interactive zoom and pan features without going through the trouble of downloading a plug-in.

Indexing – Descriptive Metadata

Indexing was the most time consuming part of the project. It constituted approximately 2/3 of the time of the project. Part of the challenge was to create consistent metadata for images from disparate source collections, which vary in the level of description. An attempt was made to provide multiple access points and index the images not only by neighborhoods and subject terms, but also by address, date, and architect name. This approach required additional research. Numerous print and online reference sources were used in the research process including historical maps of Milwaukee from the AGSL holdings and city of Milwaukee directories. A number of images required consulting with the local institutions, subject experts, and community members, and in some cases - field research. The high-resolution master images also made the research possible as they offered extensive detail and often helped in identifying the names of streets and businesses. Descriptive

metadata was first recorded in the Access database, which served as a working database. The data was then transferred to CONTENTdm to build the records.

Indexing fields were determined based on discussions with Professor Kenny, archivists, and librarians at the American Geographical Society Library. The images are indexed by photographer's name, date of photograph, neighborhood, address, subject terms, address, construction date, and name of architect, when appropriate. All records contain a unique digital ID (file name) and the date when a digital image was created. In addition, the records include information about the attributes of original source items, such as original item medium, size, ID, and repository to maintain a relationship between source items and their digital surrogates.

The images are indexed by 12 broad neighborhoods (Far North Side, East Side etc.) as defined in the 1981 publication of the Department of City Development (DCD) *Discover Milwaukee: A Great Home Town*. This publication was also used to create a map of Milwaukee neighborhoods displayed on the main page of the online collection (Figure 6). The map serves as a primary point of access for images from specific neighborhoods. In addition, the images are indexed by more detailed neighborhood boundaries outlined in the 2000 Milwaukee Neighborhoods Map. The map, published by DCD Information Center in 2000, identifies 75 neighborhoods.

An effort was made to index the images by address, when possible. As the street names and house numbers in the city of Milwaukee were changed in 1930, the current addresses and pre-1930 addresses were recorded. *The Wright's Street Guide Supplement to 1930 Milwaukee City Directory* was used to cross-reference the addresses. The data in the address

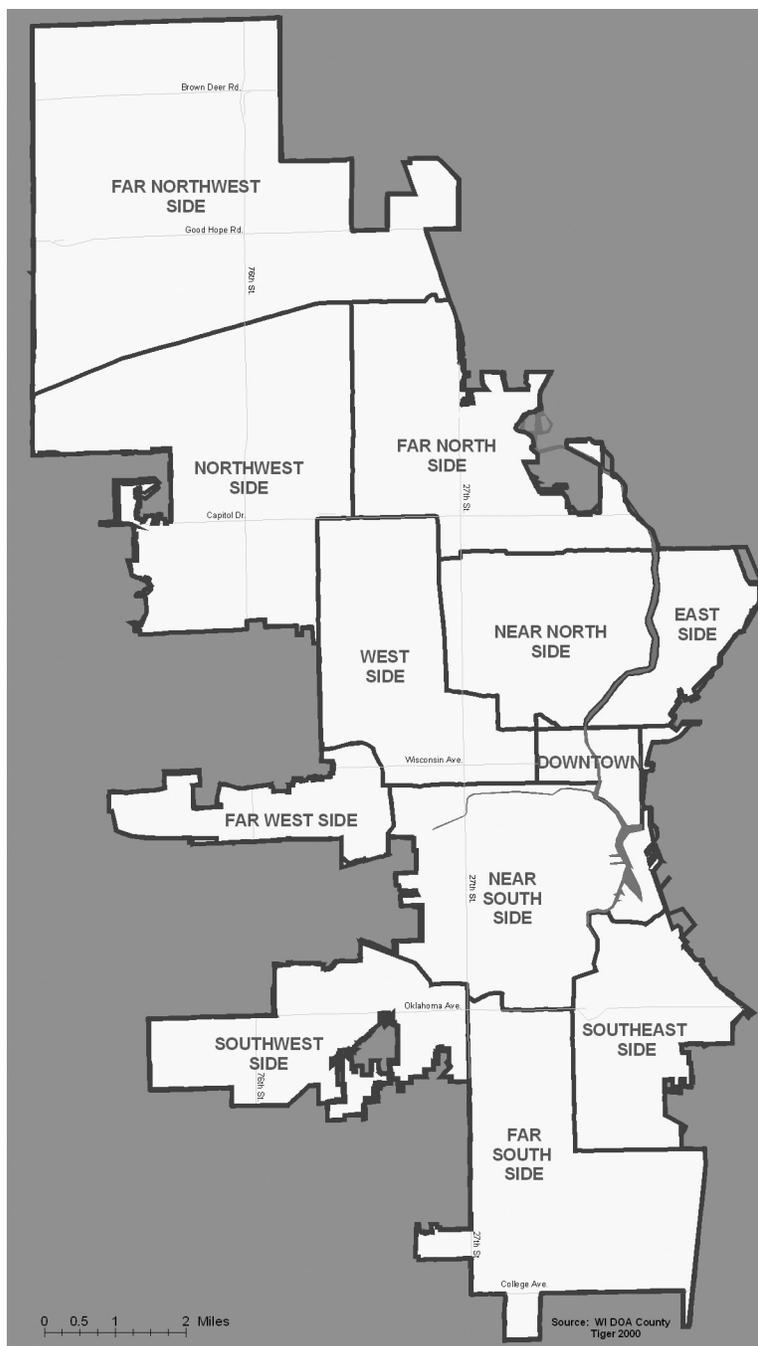


Figure 6. Map of Milwaukee neighborhoods featured on the Home page of Milwaukee Neighborhoods: Photos and Maps 1885–1992.

field is standardized, e.g. 2420 N Terrace AV. There is no punctuation and the following abbreviations are used: ST for street, AV for avenue, RD for road, PL for place, and PK for parkway.

The images are described by subject terms using controlled vocabulary. *Library of Congress*

Thesaurus for Graphic Materials (<http://www.loc.gov/rr/print/tgm1/>) was used to assign subject headings. In addition natural language terms, such as breweries, movie theaters, taverns, and tanneries, are listed in Alternate Terms field. Natural language terms were added to overcome the

limitations of controlled vocabulary and ensure that users have a greater chance of finding images on the topic of interest. There is, for example, no term in the LC Thesaurus for Polish flats, a local phenomena, but relevant to the history of Milwaukee architecture.

In-depth indexing of subject matter using both controlled vocabulary and natural language was undertaken to ensure effective resource discovery. Subject indexing supports quick keyword searching and increases the chances of successful image retrieval. Controlled vocabulary and natural language terms accommodate a variety of users. A librarian may type "motion picture theaters", while a casual user will enter "movie theaters", but both should retrieve pictures of historic movie theaters in Milwaukee. Extensive descriptive metadata not only enhances intellectual control of digital objects, but also builds relationships between images from disparate source collections allowing users to understand them in a new context.

Building an Online Collection

CONTENTdm, a digital media management system developed by the DiMeMa company (<http://www.contentdm.com>), was used to create a digital collection for Web delivery. The records were built using a Dublin Core metadata template. A number of default html and Java script templates provided by CONTENTdm were customized to design consistent navigation and create a graphical identity for the *Milwaukee Neighborhoods* collection. In addition, several HTML page were designed to provide a unique collection interface and multiple points of access.

Dublin Core (<http://dublincore.org/>) was selected as a standard for descriptive metadata. A default Dublin Core metadata

template provided by CONTENTdm was customized to accommodate a larger number of fields in the *Milwaukee Neighborhoods* project and offer natural language field labels specific to the collection, such as Photographer, Date of Photograph, Architect/Builder, Date of Construction, Neighborhood, etc. These fields were then mapped to Dublin Core to ensure interoperability and effective cross-collection searching, e.g. Photographer is mapped to Creator and Date of Photograph is mapped to Date.Created, and Neighborhood is mapped to Coverage Spatial.

The template was further customized to provide additional fields for cataloging maps. Four fields (Requirements, Map Publisher, Map Publication Date, and Scale) were added to the original list. Because the maps are indexed along with images in the same database, users can search for both resources from one search interface. In addition, access to map records is provided from a separate Maps page at <http://www.uwm.edu/Library/digilib/Milwaukee/records/maps.html>.

The collection interface was designed with a user-centered approach to accommodate a variety of users and their different search styles. The Home page features an interactive map of Milwaukee with links to the images in the collection. The map can serve as a first point of access enabling users to browse through the images of the neighborhoods. In addition, the Home page provides a search box allowing users to perform a keyword search across all fields in the collection. The Advanced Search page presents the option of performing a keyword search across all fields or searching an individual field. It also offers pull-down menus with the hyperlinked controlled vocabulary from the Neighborhoods, Subject, and Business/Place fields. The

pull-down menus expose the vocabulary, so users can become familiar with indexing terms. The Browse page is intended for users, who prefer to look through sets of images rather than type specific terms. It displays a number of thumbnails as visual clues indicating the content of the collection, highlights major subject categories and source collections, and enables users to browse the images by date of photograph. Broad subject categories not only demonstrate the content of the collection, but also provide intuitive browsing pathways.

There is also a separate HTML page with an article by Judith Kenny, "Picturing Milwaukee Neighborhoods". The article complements the image and map collection by framing the pictures in the historical and social context. It outlines the development of Milwaukee neighborhoods from the early commercial expansion in the second half of the 19th century through changes in the post World War II era.

The collection interface offers multiple options for accessing the collection to meet the preferences of a variety of users. It provides simple and advanced search functions, the Browse page with a number of predefined queries, hyperlinked subject headings within the records, and an interactive map on the Home page. The historical maps can be accessed from the Maps page or by searching the collection. The site provides consistent navigation and merges HTML pages with customized CONTENTdm templates. The collection interface facilitates leisurely browsing, serendipitous resource discovery as well as a simple keyword searching, a preferred search style of a younger generation of Internet users. The evaluation study of the *Milwaukee Neighborhoods*, conducted in the spring of 2004, found a strong preference for keyword searching

among undergraduate students, while older community users selected browse options more frequently.

Conclusion

Building *Milwaukee Neighborhoods* was a truly collaborative process, which involved several librarians, archivists, graduate student assistants, and first of all faculty. Partnership with faculty was very effective and resulted in creation of a new educational and cultural resource. The library became more engaged in the research and learning behavior of its users recognizing that research preferences of students and faculty have changed. If the Web has become a preferred source of information, it only makes sense for the library to bring its unique resources to the users via digital technology and Web delivery. Cooperation with faculty allowed the Libraries to better recognize user needs and to match the Libraries collections with the research interests of the academic community.

The digital project gave the UWM Libraries an opportunity to showcase archival collections, raise public awareness that these resources exist, and increase the visibility of rare materials, which often are not easily accessible due to their fragile nature. In fact, many of the visual resources featured in this collection are kept in remote storage areas and cannot be easily used. *Milwaukee Neighborhoods* encourages new scholarly use of these unique primary sources. The digital collection not only provides an easy access to these resources for the current library users, but also reaches a wider audience in the online world.

Digital library standards and best practices were followed in the collection building process. The standards were applied consistently to not only ensure the

good quality of the images and descriptive metadata, but also to support interoperability and sustainability of the collection over time. A digital collection, however, is not a static finite object, like a published monograph or a photo album. The process of building or "publishing" in the digital world is never finished. There are definite advantages to this approach. The records in the *Milwaukee Neighborhoods* have been updated with input from the users after the collection's release. In the future, the collection can also be revised and updated in response to user expectations and to incorporate new digital technologies. UWM Libraries is planning to adopt the JPEG2000 standard to create more interactive environment for the presentation of images and maps in this collection. Improvements will also be made in the near future by expanding the collection geographically and chronologically with the incorporation of slides and photographs from faculty members.

URLs Cited

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Dublin Core Metadata Initiative: <http://dublincore.org/>

JPEG2000: <http://www.jpeg.org/jpeg2000/>

LC Thesaurus for Graphical Materials: <http://www.loc.gov/rr/print/tgm1/>

LizardTech: <http://www.lizardtech.com/>

Milwaukee Neighborhoods: Photos and Maps 1885–1992: <http://www.uwm.edu/Library/digilib/Milwaukee/index.html>

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reviews

Manual of Aerial Survey: Primary Data Acquisition

By Roger Read and Ron Graham, Boca Raton, FL, CRC Press LLC, 2002. 408 pp., 18 chapters, with a glossary, eight appendices, and an index. Hardbound (ISBN 0-8493-1600-6), \$119.95.

Reviewed by Daniel G. Cole
Geographic Information Systems
Coordinator
Smithsonian Institution

The authors present this book as a "practical text" (p. vii). Indeed, the writing style reads like a how-to manual of aerial photographic business operations. Read and Graham successfully keep the text relatively simple with a liberal sprinkling of equations (134 mathematical formulas) and clear graphics. They admit to using their lecture notes at the ITC in the Netherlands as the basis for the book's first edition in 1986, and it is likely that they continued that practice with this heavily revised new edition. The book is also meant to be used as a companion to *Small Format Aerial Photography* by Warner, Graham and Read (Whittles Pub., 1996). While they have written the book for an international readership, it is Eurocentric. This bias is generally unimportant, although the authors have ignored several important American publications: Greve, C.W., ed., 1996, *Digital Photogrammetry: An Addendum to the Manual of Photogrammetry*, ASPRS; Philipson, W., ed., 1997, *Manual of Photographic Interpretation*, 2nd ed., ASPRS; Shenk, T., 1999, *Digital Photogrammetry*, TerraScience; and Wolf, P.R., and B.A. Dewitt, 2000, *Elements of Photogrammetry: with Applications in GIS*, McGraw Hill.

And in Appendix 1, "Institutes and Societies," the International Society of Photogrammetry and Remote Sensing is surprisingly absent.

Chapters one and two give a quick historical background on aerial photography followed by definitions with some general requirements and specifications. These specifications are further expanded and cross-referenced in Appendix 4. The instructions given here and elsewhere often tell the readers what they *should* do (my emphasis). Among the first quibbles with the book are the slim descriptions of applications on pp. 18-19. These five categories of applications could easily have been expanded a bit. The copy editor seems to have caught nearly all of the typographic errors before the book went to press, although on p. 22, figure 2.6 is referenced when figure 2.7 is the likely preferred photo. Regardless of these errors, the text, graphics and equations are presented in a clear and understandable format.

Read and Graham then dive into the meat of the book with a detailed discussion of air camera instrumentation (chapter three), staying as up-to-date as possible with comparisons of Leica, Zeiss, and Z/I Imaging. Another minor quibble crops up in this chapter as figure 3.14, a color photo, requires searching by the reader since it and another color figure for chapter four (4.16) appear in chapter 8, while the color figures for chapters five (5.6) and eleven (11.16) appear in chapter nine. Either the book designer preferred random placement of these figures or didn't care. Traditionally, all color images appear together in a central location. But since only four color images appear in the text, the first two could have been placed between chapters three and four, with the second two after the end of chapter five.

Chapters four, five, and six deal with films, exposures, and process-

ing. The authors do a good job of discussing and comparing the different film types available from Kodak and AGFA, while noting the advantages and disadvantages of each. With the review of exposures, they provide recommendations (e.g., Kodak Aerial Exposure Computer) and warnings (e.g., regarding under- and over-exposures for oblique and snow scene photos, respectively). In the processing chapter, they assess the different chemicals and processing machines, with additional recommendations for archiving.

Photogrammetric requirements are presented next with a perhaps overly restrictive instruction to have mapping cameras recalibrated at least once per year. Read and Graham provide a thorough overview of this topic, as well as evaluating advances in instrumentation, and specifically conduct a comparison of a variety of film scanners. Chapter eight delves into the ten in-flight variables and the ten post-flight variables concerned with materials and processing that affect image quality.

Business and practical operations of aircraft (chapter nine with additional comparative aircraft specifications in Appendix 8), including the advantages and disadvantages of single versus twin-prop airplanes, retrofitting and installation of air photo equipment, and navigation sights are dealt with separately. Due to automated GPS land survey flight management systems, whether this last factor will be discussed as other than an historical artifact in future editions remains to be seen. Specific annual and direct operating costs are laid out for the air photo business person on p. 214. The authors properly note that high altitude aerial surveys are no longer economical given the availability of high-resolution satellite imagery.

Critical mission planning (chapter eleven with additional

formulae in Appendix 5) followed by two phases of operational procedures are then laid out to efficiently and cost-effectively run an air photo business. One noticeable but minor typo pops up in chapter 13 where two different equations are assigned the same number (13.3) on pp. 311 and 317. The authors next provide two chapters on system-based survey navigation, as specifically related to satellite navigation systems, followed by a brief nine-page review of differential GPS with a noteworthy calculation of the cost savings in regard to its use.

The book finishes with several disparate chapters on oblique aerial photography (with oblique scales defined in Appendix 7), airborne laser terrain mapping, and close with current and future developments. Overall, even with the minor criticisms stated above, this book should be required reading for the employees of any aerial photographic acquisition or aerial survey and photogrammetric companies. That said, this reviewer doubts that the book will be used outside of that narrow audience. More traditional air photo interpretation texts will likely continue to dominate in college classrooms.

Community Geography: GIS in Action

By Kim Zanelli English and Laura S Feaster

Published by ESRI Press in Redland, CA, June 2003.

280 pages, with CD-Rom, photos, screen shots, maps, charts, graphs, tables.

\$24.95 softbound (ISBN 1-58948-023-6)

Community Geography: GIS in Action Teacher's Guide

By Lyn Malone, Anita M. Palmer, and Christine L. Voigt

Published by ESRI Press in Redland, CA, June 2003.

133 pages, with screen shots, maps, charts, graphs, tables.

\$9.95 soft spiral bound (ISBN 1-58948-051-1)

Reviewed by Beth Filar Williams, educational library consultant, Durango, Colorado

The softbound book titled *Community Geography: GIS in Action* contains real world examples exploring the use of Geographic Information Systems to answer geographical questions within local communities. The companion spiral-bound *Teachers Guide* integrates the book's case studies with practical community projects students can perform on their own. A CD-ROM is also included in the book containing GIS data for all exercises. Together these resources offer a comprehensive collection of case studies, lesson plans, exercises, and assessment tools any teacher can use in a 5-12 grade classroom or for any one interested in geographically based community issues and GIS.

The authors of the book *Community Geography*, Kim Zanelli English and Laura S Feaster, are both affiliates of ESRI Educational Products. English is an instructional designer and educa-

tor. Feaster is a geographer and educational specialist. Feaster has also co-authored others books including *Getting to Know ArcGIS Desktop*.

The book consists of two parts. Part One "community mapping projects" contains eight modules and utilizes most of the book's space. The first module "The GIS Basics" is a great beginner or refresher exercise of the basics GIS, especially ArcView 3.x. The remaining seven modules tackle one of seven case studies describing community GIS projects completed by students, teachers and community partners through the US and Canada. The seven modules themes are reducing crime, a war on weeds, tracking water quality, investigating point-source pollution, getting kids to school, managing the community forest, and selecting the right location (for a wildlife area). Following each of the case studies are intermediate level exercises related to the module's theme. These exercises offer hands on experience with GIS, data, and analysis relevant to the case study's theme. The companion CD-Rom, included in the book, contains all necessary data and ArcView 3.x projects to complete these exercises. Lastly following the case studies and exercises is a section entitled "On Your Own." These special sections in each module offer tips, ideas, and guidance for creating similar projects in the local community.

Part two of the book "on your own: project planning," illustrates how to build a community GIS project of your own independent of topic. After defining a project framework with some general questions to first ask, the authors' describe in detail the five-step method of the geographic inquiry process. These steps are:

- ask a geographic questions
- acquire geographic resources
- explore geographic data

- analyze geographic information
- act on geographic knowledge

This five-step process is first introduced in the “how to use this book” section at the start of the book, explaining how all the unique case studies are organized around this geographic inquiry process. With a new table of tasks and suggestions for each of the five steps, the authors’ provide an easy method for applying the knowledge gained in the case studies to creating a local community project with GIS. The book concludes with a list of references and resources, listed by module, and installation guides for the CD-Rom.

The *Teachers Guide to Community Geography: GIS in Action* presents “how-to” exercises for teachers seeking to apply the book with students in the classroom. Written by teachers and tested in classrooms, this guide anticipates questions and issues that may arise within all eight modules of the main book.

The authors Lyn Malone, Anita Palmer, and Christine Voigt are also co-authors of another ESRI book *Mapping Our World: GIS Lesson for Educators*, winner of several geographic educational related awards. Malone specializes as a consultant in educational application of spatial technologies. Palmer is an educational technology consultant. Voigt is a technology coordinator.

The general purpose of this *Teachers Guide* is to provide resources for educators using the book *Community Geography* to complete many of the “on your own” projects. Included in the guide are lesson plans, assessments, rubrics, tips for teachers, and correlations to national geography standards as well as science and technology standards.

The layout of the *Teacher’s Guide* correlates to the eight modules in the book. Each mod-

ule section consists of a lesson plan for teachers to use in their class, corresponding to the theme of the case studies in the book.

The lessons are structured giving an overview, time estimates for each part of the lesson, materials needed, standards addresses (for both middle and high school), objectives, GIS tools and skills needed to complete this lesson, the geographic inquiry steps, lots of teacher notes, and assessments (for both middle and high school) – including black and white copies to print for students if needed for a particular module. Following the lessons, each module has an “on your own” section, similar in theme to the “on your own” section in the book. In the guide, the “on your own” section is much more detailed, with objectives and teacher notes, and stressing a more local focus. While the book provides general information for anyone to read, discuss, or initiate, when asking a geographic question and applying it to their local, the guide is more of a classroom based activity to have individual students, groups or a class complete.

Following the modules in the *Teacher’s Guide*, are a great list of references and resources – some online and other print resources. Both general resources are listed as well as resources by module. A table lists the 18 National Geography Standards and how they correlate to each module. Another table lists both the National Science and Technology Standards and how they correlate to the modules. All of these tables show both the middle and high school standards separately so teachers from 5-12 grades can easily use it. The last section of the *Teacher’s Guide* contains the answer keys to any assessments within the book.

Requirements to efficiently use these resources, includes a computer running Microsoft Windows or Apple Macintosh, ESRI’s

ArcView 3.0 (or higher) software (and license) and an introductory knowledge of GIS and/or ArcView. More information on purchasing this software can be found online at: <http://www.esri.com/shop>.

This book can be used alone as a resource for those seeking to learn more about community GIS projects, as a supplemental text in a college course, or as GIS practice using the data on the CD-Rom and related exercises. The book can also be used as a resource kit along with the *Teachers Guide* for educators and students in any middle or high school environment. Orders can be placed with ESRI for classroom set with multiple book copies and one teacher guide. Further resources are available online at <http://www.esri.com/communitygeography/>. This web site included information on the book(s), an online discussion forum, FAQs, updates, internet resources for each module, access to online software, GIS educational training opportunities, and an online store for purchases.

English and Feaster, the authors of *Community Geography* used actual case studies in schools with over 200 people participating overall. Having applied and examined the activities before publishing the book provides comfort to anxious users. The lessons have been tested in classrooms. English and Feaster thank all those who were so inspired to learn and use GIS to better their own communities, and in turn helped them with the book’s content. The authors’ are to showcase some of these amazing student accomplishments with GIS in the community, as well as, draw on other to be creative, dedicated, and enthusiastic toward community geography and GIS. In the author’s acknowledgment they state “it is not necessary to be a GIS professional to embark upon

a GIS project that provides great benefits to the community.”

Jack Dangermond (president of ESRI) wrote an insightful forward for the book where he tells his “tree story.” Before ESRI was a thought, when he was just a young adult, Dangermond was involved in community geography projects such as those described in the book. He entered a contest on “Redlands Beautification” and won. Today the trees planted in the town center still shade shoppers and make a clear difference in the community. Dangermond implores young people to use their imaginations; ask, explore, analyze; and make a difference in the world. The authors mention this story stating that even a small community project can make a lasting significance in a young person's life and community.

The book's organization allows the user to skim and jump right into the most interesting or relevant module. Studying water quality or air pollution? Jump right to these specific modules. Flexibility, well organization, and ease of use are strengths of the book. The seamless way both the book and guide fit together provides convenience to use as a package for any educator with a basic GIS knowledge to apply in their classroom. Though these two companion books are written by different authors, the book's acknowledgement states that all the authors contributed from planning together to creating the “on your own” and exercise sections, allowing a flow between the two. Uses are not only for a 5-12 classroom setting, but also as supplemental modules or readings for college students, readings or activities for an interested individual or for a local community organization wanting to complete a local project. The case studies might simply be read as example to students or community groups demonstrating how other youth have affected their

communities.

The negatives of this book are its technology requirement. Of course to complete any of the exercises or activities, a computer running ArcView 3.x is a must. In a classroom setting, in order to have a class complete these activities, a lab with licenses for ArcView on each computer must be purchased. Many school districts may not see the benefits of the cost and therefore making the use of these resources ineffective or unreachable. A community organization or an individual desiring to use this book might also be turned off by the cost of the software.

Another negative is the ArcView 3.x software. Most colleges and professional GIS users run newer versions of ESRI's ArcView, called ArcGIS, almost a different GIS package. Though most data would still be compatible, wouldn't it be better to teach students the most used and most recent GIS package on the market? Perhaps the simplicity of ArcView 3.x would actually be beneficial for beginning GIS users, but several GIS professionals have mentioned this aspect as a drawback for purchase.

Another aspect, which could be either positive or negative, depending on one's view, is that both these resources are an all-around ESRI product. The creators of the book – thought not the guide – both work directly for ESRI and the ESRI Press published both these resources. ESRI dominates the GIS market, so it makes sense that the book would use their products and be produced by ESRI. Some GIS users complain of the control ESRI has on the GIS world and would not purchase this resource for that purpose only. Others would be pleased to have the standard, simplicity of using an ESRI product known to be sound and efficient.

The authors of the *Teachers Guide* are well-established educators in the world of Geography. Another

strength of these authors is for publishing a well received book called *Mapping our World*. They are not ESRI staff but actual teachers who have worked with students and/or other educators and possess the real-world educational perspective on what can and cannot be accomplished in a classroom. They have also worked the guide's exercises and tried to anticipate needs, issues and questions that might arise from implementation. The positive result is a teacher's guide from a teacher's perspective.

They have aligned lessons with national standards and included lots of resources and tools for teachers. If the *Community Geography* book is purchased with the intent of classroom use, then the *Teacher's Guide* is a must purchase companion. The structure is exactly like that of the book, allowing the ease and flexibility of use and the guide's organization to apply to both resources. The themes, the lesson, activities etc. all correlate in both resources. These two resources really are a companion set to be used together in a classroom.

Gilbert Grosvenor (chair of National Geographic Society) wrote an insightful forward for the *Teachers Guide*. He suggests that once students learn more about geography it will appeal to their natural curiosity about the world. As toward the purpose of this book, he states sad but true facts about the lack of geographic knowledge in people in general such as after the 9/11 attacks on the US, “83% of ...18-14 year olds could not find Afghanistan on a world map...” Other facts such as these are used to promote and inspire education to the importance of geography knowledge in education. Applying this to community geography, if the youth cannot find a place on a map how can they see relationships between themselves and other, understand current events, and recognize the issues globally that affect their local community?

This rousing forward from Grosvenor intends to positively inspire use of this book.

If the intent is not for classroom use, then the *Teacher's Guide* might be only a supplemental consideration. For local community groups or individuals, the teachers guide is more of a classroom text and perhaps not relevant – with tests and rubrics – to an individual. Other negative aspects of the guide are those similar to the book with the ESRI influence making ArcView a necessity to use the guide adequately and the technology requirements..

A last positive note for both resources, as mentioned earlier, is the website where users can go free of charge to peruse other online resources. The *Community Geography* (both resources) online site gives Web sites list by module, varying for the two resources that can be used as supplements. A positive aspect of online supplements is the ease at which the most recent updates, notes, studies or tips can be quickly disseminated to users. Also online is a discussion forum area, where users can post questions, ideas, or suggestions to share in a threaded discussion with others. Though no questions were posted yet, I imagine more people taking advantage of this as these resources get better known and used.

In the spirit of “think globally, act locally” the authors of both these companion resources have inspired me to take a more active role in promoting the use of GIS as a tool in implementing community projects. Anyone with community interest in mind, and general GIS knowledge, can gain much from using these books. As a practical how-to guide or as a philosophical global expansion of education in a “classroom with no wall,” this guide can be used to address global issues at home and prepare young people of today to be decision makers of tomorrow. I

recommend the book *Community Geography*, to anyone interested in learning more about GIS's practical use in a local community: running a Girl or Boy Scout troop? Working with a nonprofit nature studies organization? Or, simply with your own children in your own house? Many opportunities offer themselves as applications using this resource. I recommend the *Teacher's Guide*, along with the book, to any classroom teacher seeing the necessity of GIS and encouraging students to work on complex issues applying them to their day-to-day lives and local communities

visual fields

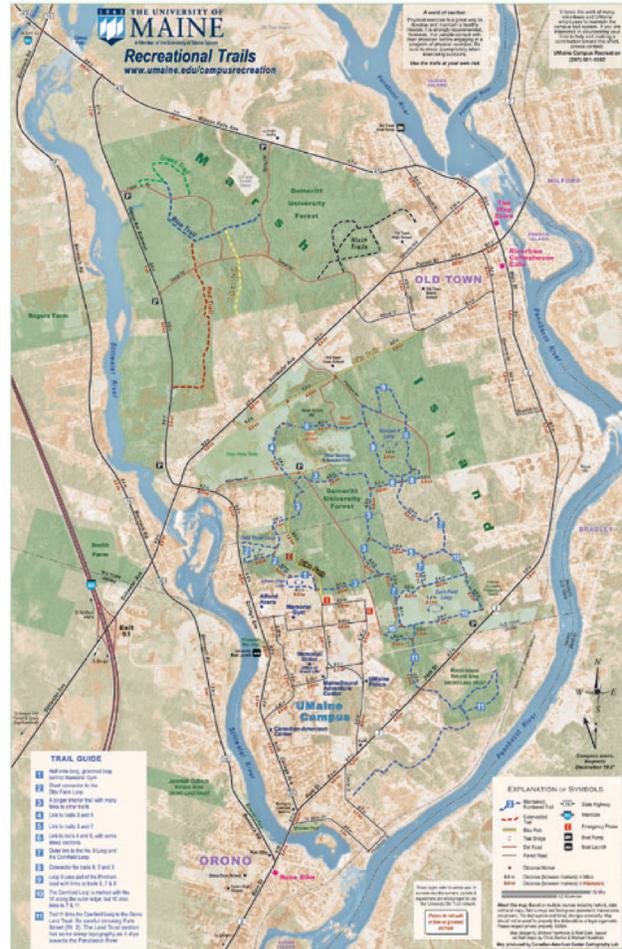
- University of Maine Recreational Trail Map 80
Designed by
Michael Hermann and Matthew Cole
University of Maine
Canadian-American Center
- Athens: 2004 Olympics 81
Designed by
Bruce Daniel and Alex Tait
International Mapping

Ever since Tom Patterson’s tutorial on colorizing Digital Ortho Quads (DOQs) I’ve been looking for an appropriate map design project to follow his lead. A redesign of the University of Maine Recreational Trail Map provided that opportunity.

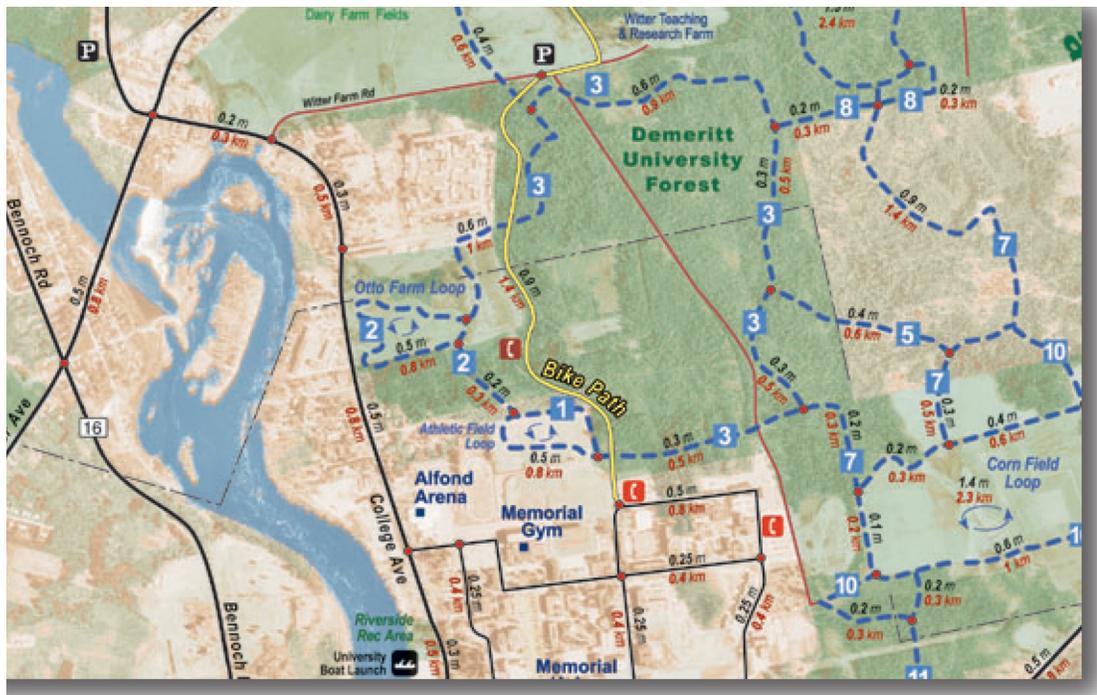
DOQs offer texture as a design element. This texture illustrates nature, visible as forests, fields, and rivers, and culture in the form of towns, roads and parking lots. This pixel-level detail eliminates cartographic ‘white space’ but makes it difficult to embellish with text and symbols commonly used on abstract maps. The DOQ-based map carries less information than an abstract map, if using traditional inventories of lines and text. It pushed our design parameters towards a deletion principle. We didn’t add the centerline and text of every street, only roads and trails suggested as recreational options; letting the pixels breathe, so to speak. Neighborhoods appear complete with back yards, open fields and shopping centers. An abstract map may symbolize public land as a solid polygon, but the DOQ reveals dense forest, logging operations, and open fields. Instead of a symbol, like a tidy square, the paper mill sprawls the way industry often does with acres of wastewater tanks. Traditional representation of river as blue polygon yields to river as image, complete with pools, ripples, and whitewater; not whitewater symbolized as three wavy lines, but actual white pixels frothing amidst blue pixels, intuitively interpreted as shallow, fast moving water. Or so the mapmakers hope. This is less cartographic data by one metric, yet infinitely more by another. Not every project benefits from the overwhelming amount of imagery a DOQ provides, but in this case we felt it offered an immediate sense of place, bringing the reader into the map on an intuitive level with minimal effort.

The map is offered in four formats: 11 x 17 folded paper map distributed on campus and at trailhead locations, 22 x 34 posters printed on demand, and on-line as high and lo-res PDFs.

Map available at: www.umaine.edu/campusrecreation/facilities/trails.htm



The published map is 11 x 17 inches, shown above reduced in size, below is a section at actual scale.



Map design by Michael Hermann and Matthew Cote, University of Maine Canadian-American Center ©2004.

International Mapping

Map of Athens 2004 Olympics

For this view of the main Olympics area of Athens, cartographers Bruce Daniel and Alex Tait of International Mapping utilized Shuttle Radar Topography Mission (SRTM) 90 meter digital elevation data draped with Enhanced Thematic Mapper Plus (ETM+) Landsat imagery. *Sports Illustrated* magazine published the image and accompanying locator maps in their August 2nd, 2004 issue.

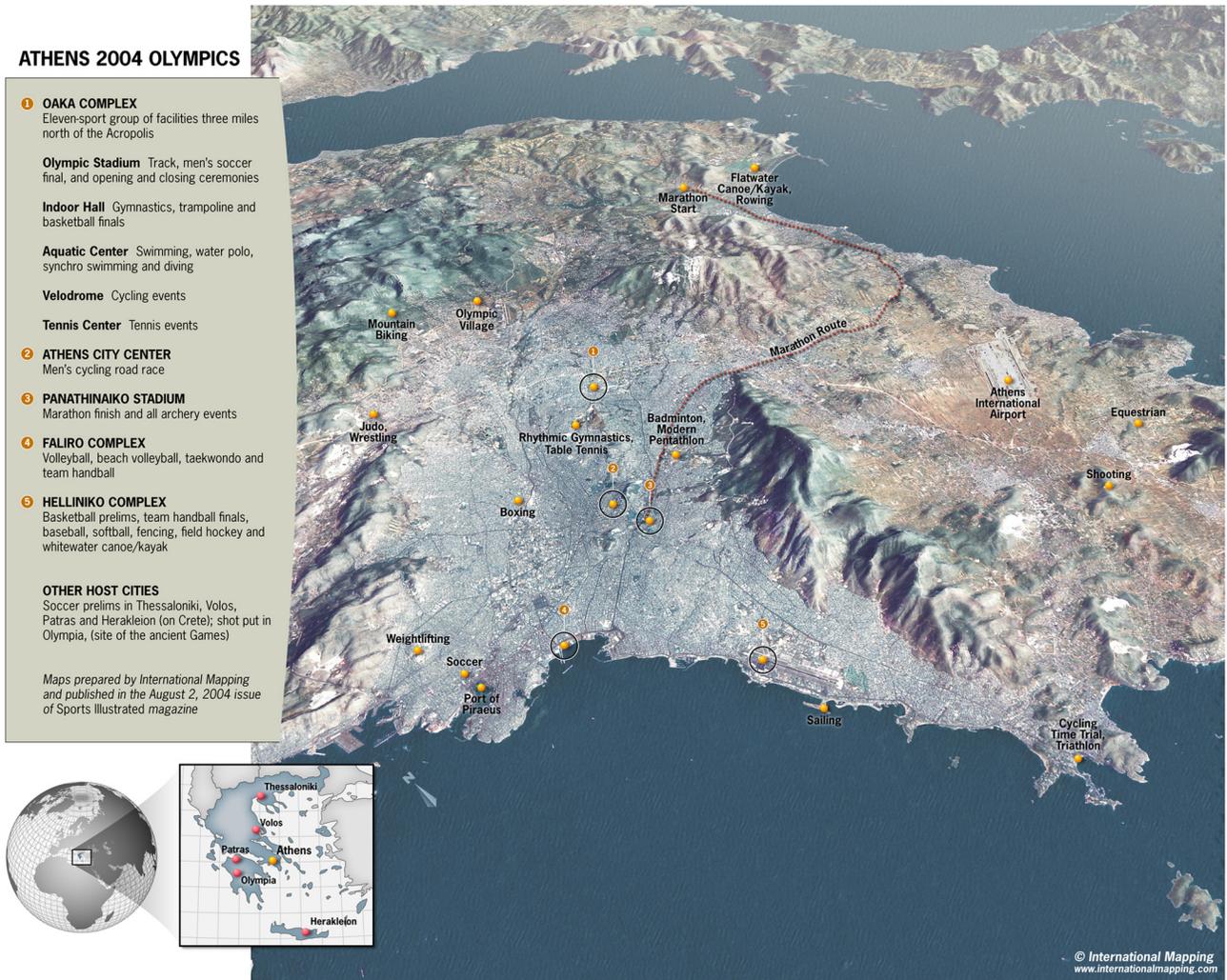
Alex and Bruce downloaded Landsat imagery from the Global Land Cover Facility Earth Science Data Interface (<http://glcfapp.umiacc.umd.edu:8080/esdi/index.jsp>) at the University of Maryland. The Athens image uses Landsat-7 ETM+ data collected from the 20th of May 2000

to 24th of August 2000. Working with Tom Budge at the Earth Data Analysis Center at the University of New Mexico, they merged the Landsat tiles using Erdas Imagine software. All seven Landsat channels were saved as TIF files and brought into Adobe Photoshop software for advanced color manipulation. Using a combination of channel manipulation and tweaking of file color space, Bruce created a final composite RGB image to drape on the digital elevation model.

To create the specialized view of Athens for this piece, Bruce loaded the SRTM elevation data into Natural Scene Designer Pro software from Natural Graphics. He then added the prepared drape image and set the desired camera attributes. The final map image is a single high-resolution render from Natural Scene Designer.

Bruce and Alex finished the map work in Adobe Illustrator, incorporating the locator maps, textual elements and annotations to the main image.

For more information contact: Bruce Daniel (bdaniel@ima-maps.com) or Alex Tait (alex@ima-maps.com) at International Mapping in Ellicott City, Maryland.



color figures

Cartographic Guidelines for Geographically Masking the Locations of Confidential Point Data	83
Civil War Topographical Engineering in the Shenandoah	84

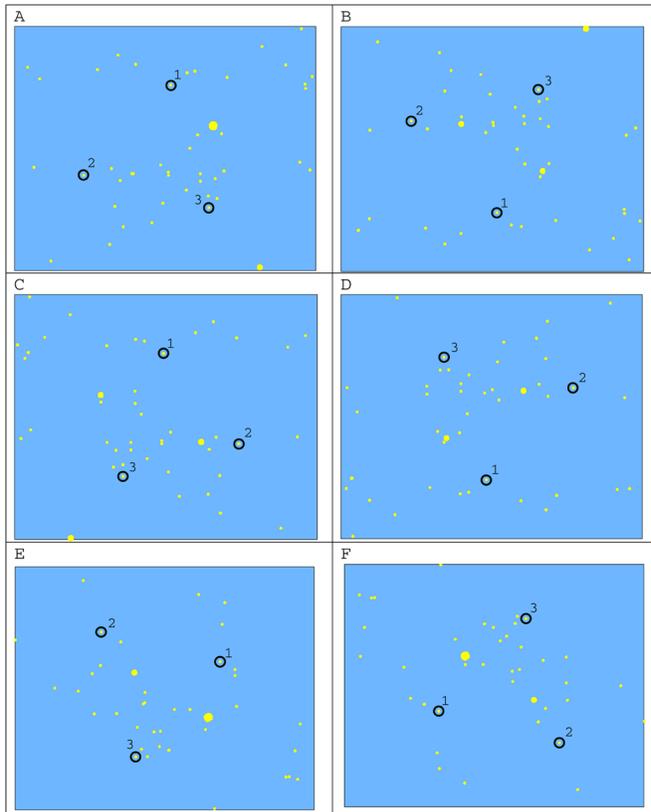


Figure 1. Global geographic masking methods used in this experiment. A) Original incident locations, B) flipping about horizontal central axis of the map, C) flipping about vertical central axis of the map, D) flipping about both central axes of the map, E) rotating around the map center by 60° to the right, F) rotating around the map center by 120° to the left.

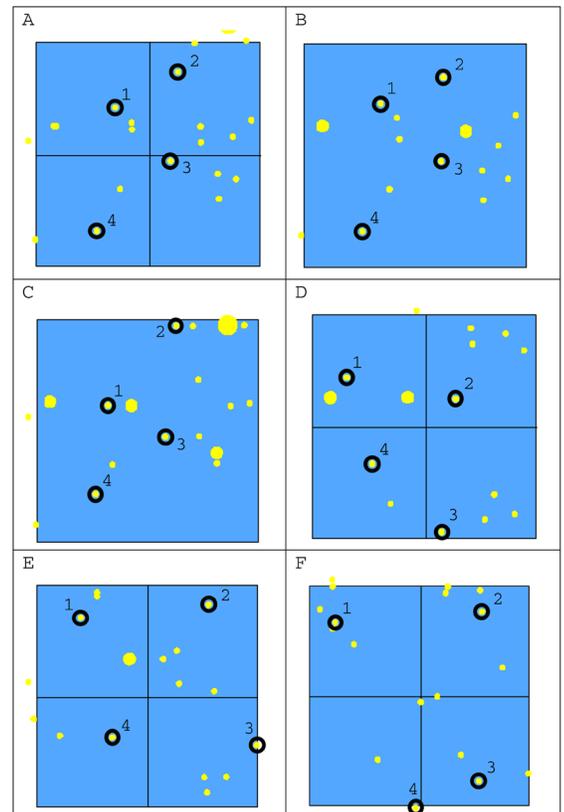


Figure 2. Local geographic masking methods used in the experiment (only a portion of the entire test map is shown). A) Original incident locations, B) spatial aggregation at the midpoint of the street segment, C) spatial aggregation at the closest street intersection, D) flipping randomly either about the vertical, horizontal or both central axes of each grid cell, E) rotating by some random degree around the center of each grid cell, F) translating by some random distance.

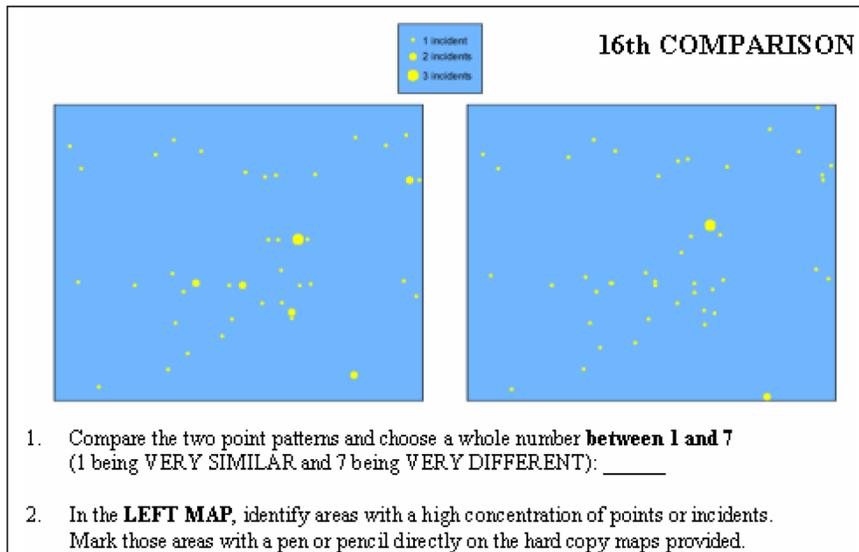


Figure 4. Example of a pair of test maps included in the experiment. All incident locations in the left map are locally masked by spatially aggregating them to their closest street intersection. All incidents in the right map are shown with their true, unmasked location.

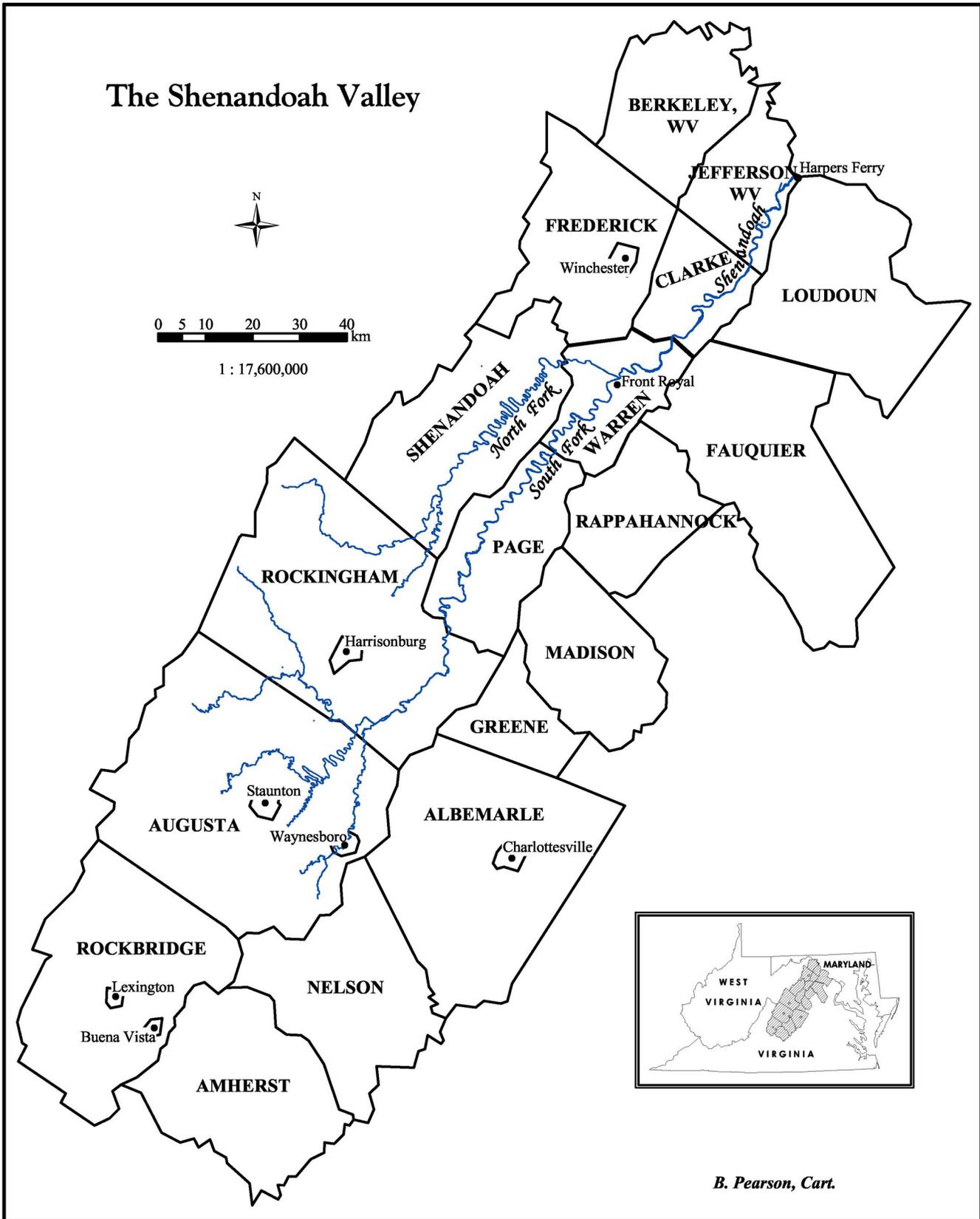


Figure 1. Map showing the theater of operations for the 1861 & 1862 Shenandoah Valley campaigns. The river system is from U.S. Geological Survey 7.5' topographic quadrangles.

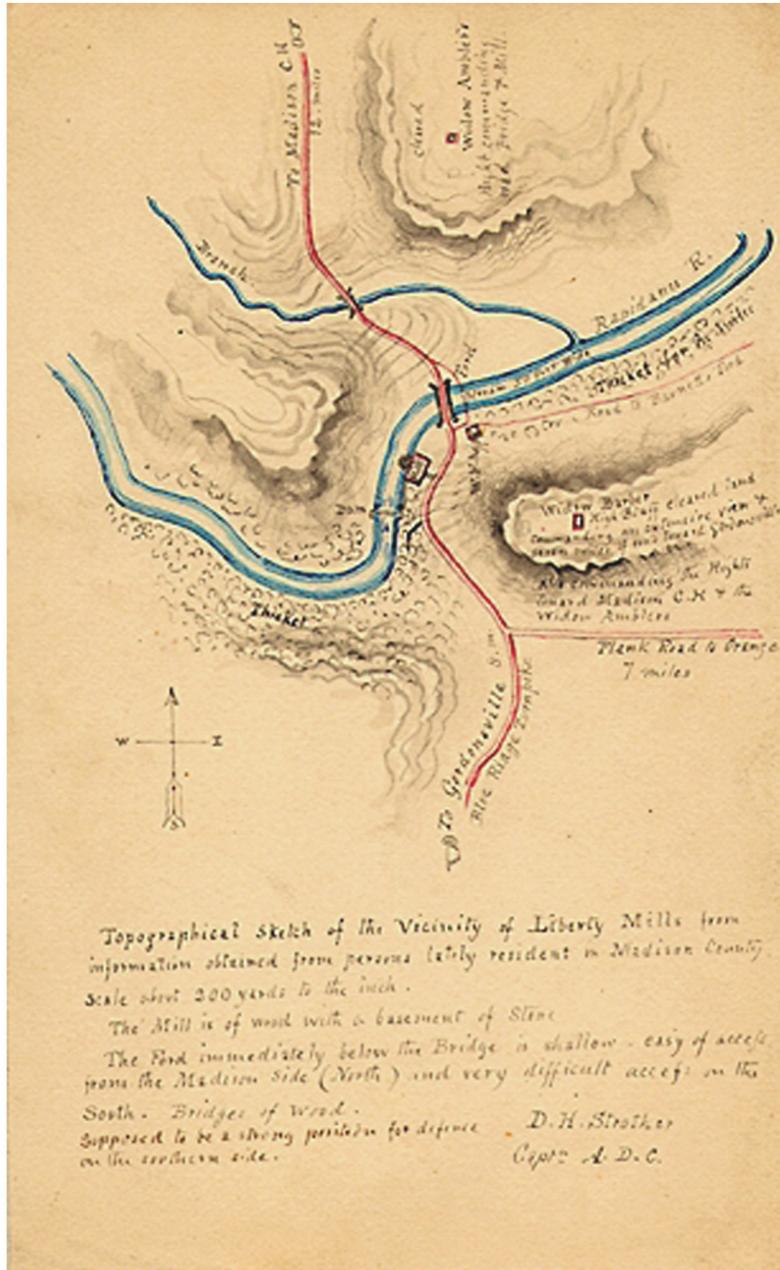


Figure 5. Strother's Topographical Sketch of the Vicinity of Liberty Mills. Source: West Virginia and Regional History Collection.

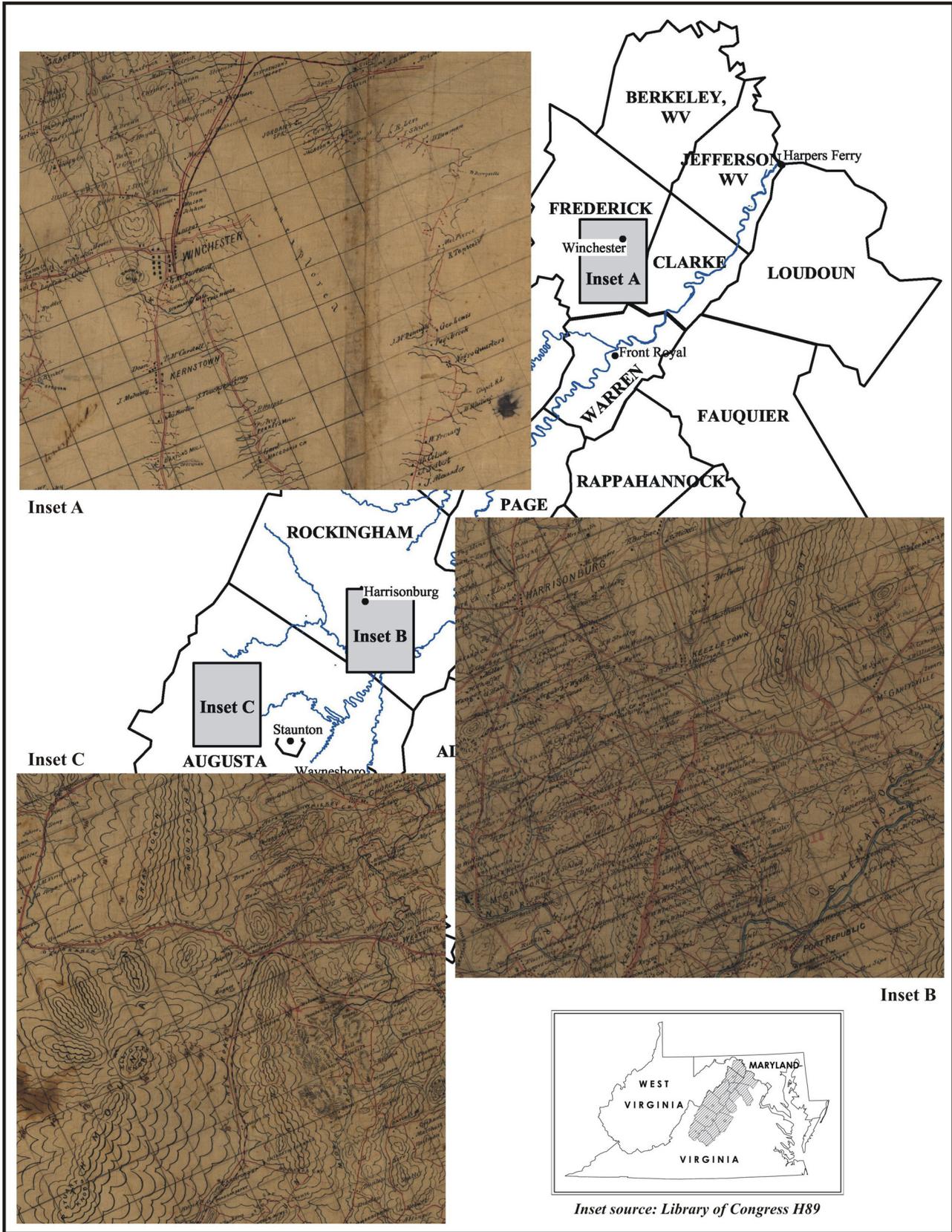


Figure 6. Details from Hotchkiss's Map of the Shenandoah Valley.



Figure 7. Hotchkiss's Sketch of the McDowell Battlefield. Source: Library of Congress H94.

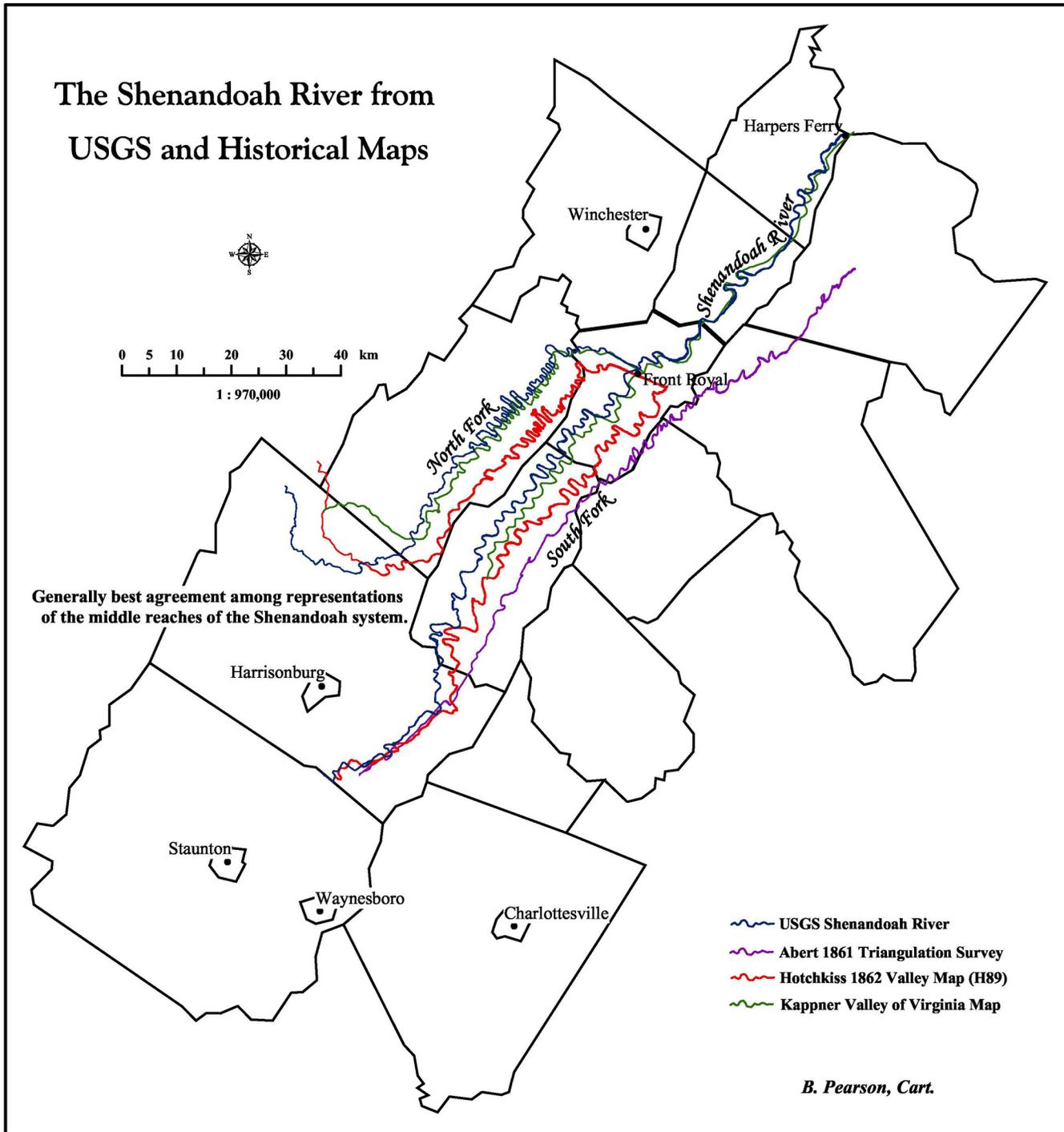


Figure 8. Map showing the Shenandoah river system as represented on historical maps by Abert, Hotchkiss, and Kappner, and in current U.S. Geological Survey data.