VISUALIZING THE PAST: TOOLS AND TECHNIQUES FOR UNDERSTANDING HISTORICAL PROCESSES

A White Paper for the National Endowment for the Humanities

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In September 2008, the University of Richmond (in partnership with James Madison University) was awarded a National Endowment for the Humanities Level 1 Digital Humanities Start-Up Grant (award #HD-50442-08) to convene a two-day workshop of leading scholars and experts working on creating visualizations of historical events, processes and datasets. More than twenty experts took part in the workshop held at the University of Richmond on February 20-21, 2009. Participants in the workshop presented cutting-edge work in historical visualizations and took part in wide-ranging discussions about the state-of-the-field and the challenges in expanding the reach and capacity of such research. Following the workshop, the University of Richmond and James Madison University conducted follow-up work to extend further our understanding of the current state-of-the-field. This white paper documents the opportunities and challenges of historical visualization research, the workshop, subsequent work performed at the University of Richmond and James Madison University, and the outcomes of the workshop in pushing forward historical visualization research.

Workshop Website:
http://dsl.richmond.edu/workshop

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PROJECT OVERVIEW

This project began with a simple question: how we can advance the work of people seeking to use digital tools to visualize complex historical processes? As a historian and geographer, we were both well aware of the growing potential for historical visualization techniques to transform our disciplines. We have both devoted much our own scholarship toward such work, and we knew from personal experience that a growing number of our colleagues were considering doing the same.

Some of this movement within the humanities and social sciences toward digital visualization tools reflects the fact that nearly all historical data has some spatial component to it. Every historical newspaper, census record, manuscript, battlefield report, audio recording, and photograph came from a particular place, and often documented multiple other locations. Access to tools that can plot the spatial dimensions embedded in these various datasets—particularly as those patterns move across the landscape of the past—can help scholars to better analyze and understand what their sources can tell them.

Others find themselves drawn to visualization research techniques as a result of the digital revolution. With digitization efforts, both in the public and private sectors, making increasing amounts of historical data available, scholars find themselves in need of new ways to sort that information. The problem for many scholars working with historical data has begun to shift from "what do you do with too little?" to "what do you do with too much?" In the age of Google, when scholars can access millions of historical sources through digital media, the challenge has become to find ways to discover

meaningful patterns in such massive quantities of information. Visualization techniques, many have recognized, offer a method of sorting overwhelming amounts of data.

Within our own work, we had experienced both of these phenomenons. As such, we had also experienced some of the common challenges besetting anyone attempting to incorporate visualization tools and techniques into their work with historical sources. Some examples from our own experiences include:

- Historical data is nearly always incomplete, leaving gaps within the available information that are difficult to represent properly in digital visualizations.
- ArcGIS, the standard in digital cartography, is a terribly complex and difficult to learn package of software.
- GIS tools tend to be poorly equipped to deal with change over time.
- If not generated locally, historical datasets nearly always have to be downloaded from a source to a local machine to be incorporated into a tool like GIS. As such, that data usually has to reformatted to a new standard in order to be compatible with the project.

We had, moreover, concluded that many of these challenges shared two underlying problems:

(1) Because the dominant GIS tool, ArcGIS, has been designed for other audiences, it still lacks sufficient tools to adequately address the needs of humanities scholars.

Nearly all spatial research is performed within ArcGIS, largely because it is the most robust and adaptable set of tools toward analyzing issues of space. As such, most scholars employ ArcGIS toward historical research that incorporates spatial analysis.

The challenge in using ArcGIS in this context comes from two directions. First, because the programs involved are highly powerful, they are also highly complex to learn. The learning curve alone, thus, prevents the widespread adoption of such techniques toward humanities research. Second, ArcGIS was not developed originally to deal with humanities-related questions. Thus the software tends to emphasize exploring datasets within a specific timeframe, rather than across time. That has recently begun to change with the development of new Arc tools aimed toward this very problem.

(2) There is little cyber-infrastructure aimed toward supporting the rapid sharing and dissemination of these various historical datasets in a manner that makes them easy to share (and thus promote enhanced research possibilities).

Although increasing numbers of scholars are both generating datasets and using digital tools to analyze them, there is very little in the way of tools, techniques or ability of these researchers to share their materials. In other words, most of the datasets being generated cannot talk directly to any other datasets. The result is that nearly every scholar using these materials must go through a laborious process of collecting various datasets, reformatting them to match a single standard for his or her own research, and then use cumbersome tools like ArcGIS to analyze them for themselves. There is little in the way of infrastructure, support, or adoption of techniques to allow scholars to grab datasets distributed across various systems that would allow a scholar to perform their work on-the-fly in a way that would speed up their efforts. The inability of scholars to share data, it seemed to us, was the most widespread and significant challenge facing scholars hoping to incorporate visualization work in their research.

Having identified both the potential for expanding the possibilities of visualization of historical resources and the challenges preventing many scholars from undertaking such work, we decided to convene a workshop where we could foster concentrated dialogue about these issues among leading scholars working in historical visualization. As such, the purpose of this project was rather simple: we wanted to identify the current state of the field, to assess current practices and needs, and to begin discussions about how to move these people forward with sharing data and connecting various efforts.

CALL FOR PAPERS

We began by issuing a call for proposals for participants for a workshop to be held on February 20-21, 2009, at the University of Richmond. We asked for abstracts of 20-30 minute presentations of ongoing projects that would address two central questions:

- How can we harness emerging cyber-infrastructure tools and interoperability standards to visualize, analyze, and better understand historical events and processes as they spread out across both time and space?

- How can user-friendly tools or web sites be created to allow scholars and researchers to animate spatial and temporal data housed on different systems across the Internet?

The response was impressive, drawing over 60 proposals from all over the world. The large number of proposals reinforced impressions we had both developed about the

widespread desire within the humanities and social science communities to expand visualization research in order to promote enhanced research and dissemination in the digital age.

We also formed a board of advisors made up of experts in the field, to assist us with evaluating the most promising proposals. The board consisted of David Arctur (Open Geospatial Consortium Interoperability Institute), Edward L. Ayers (University of Richmond), Peter K. Bol (Harvard University), David Schell (Open Geospatial Consortium), Terry Solcum (University of Kansas), and Richard White (Stanford University). (Detailed biographies of the board of advisors can be found in "Appendix 2: List of Participants.")

With the advice of our board, we invited more than 20 presenters (representing the United States, Canada, England, and the Netherlands) to come to Richmond, Virginia, for the two-day conference. Scholars selected to participate in the workshop represented a wide array of backgrounds and disciplines, including historians, geographers, computer scientists, statisticians, anthropologists, animators, programmers, and journalists. In addition to scholars affiliated with traditional universities, we also brought in various representatives of the private sector. Microsoft and Google both accepted invitations to present their latest work in visualization technology, as was the private firm BBN Technologies. We also hosted representatives from the non-profit sector (including the Open Geospatial Consortium and Open Geospatial Consortium Interoperability Institute, non-profit consortiums directed toward developing interoperability standards in supporting GIS work) and government agencies (including the Ordnance Survey, Great

Britain's National Mapping Agency). (Detailed descriptions of each presenter can be found in "Appendix 2: List of Participants.")

THE WORKSHOP: FEBRUARY 20-21, 2009

The workshop itself was organized around successive sessions of two to three presentations, followed by a round of discussion. The relatively small size of the group allowed for wide-ranging discussions in a structured, but open-ended, setting. Small discussions followed each presentation, with a larger and more comprehensive dialogue following the end of each session.

The first day's sessions covered a wide array of current work in the field:

- J. B. Owens discussed the efforts of Idaho State University to establish a lab for the use of GIS in historical geography, and the challenges of developing research techniques for addressing the inherently ambiguous nature of historical datasets.
- Chris Weaver and May Yuan discussed new software packages for analyzing historical datasets, as well as multiple possibilities for visualizing both historical landscapes and textual landscapes (that is, relationships embedded in language patterns).
- Jeanette Zernecke discussed the efforts of the Electronic Cultural Atlas Initiative to develop and promote platforms for the sharing and preserving historical artifacts and information by using time and space as organizational tools.

- Rafael Alvarado discussed the use of RDF as a means of organizing and sharing historical data in a manner that could promote sharing and exchange of historical data for visualization research.
- Kurt Rohloff discussed recent data-mining efforts at BBN Technologies to use historical sources in order to create algorithms for predicting the geographic locations of future cultural events.
- David Arctur and Phillip Dibner discussed interoperability standards for GIS developed by the Open Geospatial Consortium (OGC) and the Open Geospatial Consortium Interoperability Institute (OGCii) and their applicability toward promoting historical GIS efforts.
- David Bodenhamer discussed efforts to translate GIS's capabilities into web-accessible interfaces, and the challenges and limitations that exist for scholars who seek to distribute such work online.
- Peter L. Pulsifer discussed developing a cyber-infrastructure to support "cybercartography" as a means of promoting visualization as a means of analyzing historical data, promoting the use of OGC standards to promote such work.
- Charles van den Heuvel discussed two projects aimed toward developing new techniques in the annotation and contextualization of manuscript maps, focusing on the need to develop technology that enables scholars to better analyze these maps while also preventing the casual distortion of those maps through digitization.

- Max Edelson and Alan Craig discussed efforts to geo-locate map manuscripts effectively without using proprietary GIS software, while at the same time making such maps available through KML as a means of delivering them online.
- Josh Wall presented and discussed the "Surface" environment developed by Microsoft to promote collaborative work in a visualization-rich environment.

The second day of the workshop continued with presentations covering:

- Peter K. Bol discussed various projects underway at Harvard's Center for Geographic Analysis, emphasizing the deep-set need for the development of better tools (such as historical gazetteers) for programmatic identification of place names in historical sources (particularly in languages other than English)
- Jon Christensen discussed the development of the Spatial History Project at Stanford University, and their efforts to combine GIS, cartography, and spatial analysis through a variety of software platforms and tools, all aimed toward moving beyond the confines of ArcGIS.
- Hadley Wickham discussed using the statistical analysis tools available as "R" toward developing visualizations of information sets, focusing in particular on the problem of dealing with incomplete datasets (a near constant when dealing with historical data).
- Sorin Matei discussed the possibilities for developing immersive visualization environments for exploring historical datasets, as well as incorporating those datasets into rich KML layers for distribution through Google's mapping and visualization platforms.

- Carsten Roensdorf discussed the development of CityGML by the United Kingdom as a means of developing more semantically rich data structures for the preservation and dissemination of historical data about buildings and spatial relationships within cities.
- Mano Marks discussed Google's wide-ranging platforms of tools available for geospatial plotting and sorting of information sets, concentrating on the capabilities of Keyhole Markup Language (KML).

COMMON ISSUES IDENTIFIED

The projects presented at the workshop represented wide-ranging approaches to visualizing historical datasets, usually toward very different ends and goals. Yet there were common threads that ran throughout the presentations and the discussions they elicited. Foremost, of course, was the common approach to using visualizations to explore both large and complex datasets as they move across both time and space. There was a shared sentiment among those assembled, both in the presentations and the discussions that followed, that visualizations offer scholars the ability to make sense of various sorts of data (and the data analyzed in the various projects ranged quite widely, from Chinese to English, from newspapers to videos, from manuscripts to audio recordings) in ways that enable researchers to detect more easily embedded patterns, organize their information, and generally make sense of complex problems.

In terms of the data itself, one of the most common challenges identified in creating visualizations of historical information is the problem of ambiguity. Throughout numerous presentations and discussions, the problem of incomplete datasets due to

incomplete historical information was identified by workshop participants as a looming and unresolved issue within historical visualization work. Nearly all historical datasets are problematic because of their incomplete nature (this is, in fact, a problem with nearly all large datasets, as one participant—Hadley Wickham—pointed out). What remains unclear is what is the best method for addressing (and being transparent about) those gaps in the data when creating visualizations. Different projects handled that question in very different ways—some found explicit means for identifying missing data (thus drawing attention to that issue for the reader), while others simply ignored those gaps in their representations (thus allowing the reader to imagine a completeness to the data that might not in fact be the case). Within the field, there remains no clear consensus on how to address such issues, and no accepted (and thus clearly recognizable) method for alerting readers of where gaps in data are expressed in a given visualization of historical information.

Indeed, an area that was not explored in depth at the workshop but was seen as highly important for future work related to visualizing the past relates to spatial and temporal reasoning and cognition. Specific areas brought up at the workshop include the concept of precision and the need to develop ways to evaluate the vagueness of qualitative data and portray margins of error inherent in incomplete historical data. Workshop participants also expressed interest in developing better ways of using natural language and meaning representation in conveying information, and in particular the use of a narrative model of presentation. There was also an interest in going beyond spatially referenced visualizations to use visual vocabularies.

In terms of the tools available for creating visualizations, ESRI's suite of tools for GIS are clearly the most widely adapted toward historical visualizations and analysis in use today. In fact, there is nothing else that comes close to the dominance of ESRI's toolsets in this work, and the vast majority of the projects undertaken by the workshop participants incorporated some form of formal GIS software (usually ArcGIS). Permutations of GIS found its way into the presentations both in direct form (such as Bodenhamer's discussions of the challenges in translating GIS capabilities to a web-ready environment) or indirectly as a means of organizing information that was then later presented through another tool (such as in Ferster's discussions of developing a Flash-based tool for historical visualizations, which can incorporate GIS shapefiles). Much of this, it seems, reflects the fact that the majority of these projects seek to pin information down to specific geographic locations, for which ArcGIS remains the standard. Yet even projects that do not have a specific landscape upon which to layer data (for example, a project being undertaken by Yuan to begin to use GIS to map the language patterns embedded in large collections of digitized texts) are using GIS software as a means of organizing datasets in spatial dimensions.

The dominance of ArcGIS as the toolset for performing geospatial analysis means that the limitations of those same tools prevents some scholars from taking advantage of historical visualization research. Although ESRR has several tools and platforms for making GIS files accessible on the web, many of the participants at the workshop noted the challenges of translating the capabilities of ArcGIS (such as layering multiple datasets over a particular landscape) into a web-ready environment. Other participants addressed the challenges of addressing change over time, and the animation of data-patterns as they

evolved over a time-series, through software that was designed primarily to address a single time and place at any given instance. Indeed, many of the projects presented sought to address these difficulties by creating new software and/or platforms to fill in these gaps in capabilities. Simply put, there is nothing that comes close to competing with the capabilities of ESRI's suite of GIS software, and thus the vast majority of scholars use the software for geospatial and visualization research. Yet the fact that these tools were not designed specifically for the humanities means that they are sometimes unable to meet the research needs of such scholars.

The second most common tools seen during the workshop were the various platforms offered by Google (primarily through the use of KML in Google's Maps and Earth projects), in large measure because they appear to offer highly accessible solutions to perceived limitations of ArcGIS. KML, for example, can easily be translated into a web-environment, has a tremendous amount of flexibility due to its stripped-down simplicity, and can be easily distributed and disseminated across a wide-ranging variety of platforms. The openness to KML easily lends itself to sharing of data (an indispensible consideration in the support of scholarship) and the adaptation of a digital project into various web-based interfaces. Moreover, there are a large (and ever-increasing) number of software programs that can translate GIS shapefiles into KML files, making the transition from a GIS environment to a KML environment an increasingly easy endeavor.

Several projects presented at the workshop, in fact, combined GIS and Google's KML platforms. The combination of these two tool-sets appears to be becoming a standard for layering historical information across a landscape (done with ArcGIS) and

then disseminating that information in another format that is highly accessible to a wide audience (through KML and Google's platforms). KML also enables scholars to take advantage of Google's tools for time-lapse animation, something that is now also available in ArcGIS software. That enables researchers to take GIS layers developed for different times and pull them together into a geo-referenced time-series, allowing the user to analyze information as it changed over both time and space simultaneously and therefore extending their ability to reconstruct patterns embedded in their historical datasets. Many of the scholars at our workshop had identified these as key advantages of combining their work in GIS with KML as a delivery system, and the two tool-sets figured predominately in a large number of the projects presented.

The advantages of KML as a delivery—and thus dissemination—tool for historical visualizations is further extended by the fact that Google provides multiple platforms upon which to distribute and disseminate these datasets. Rather than create and maintain the platforms upon which KML would operate, these scholars relied instead on the platforms provided by Google through the Google Maps API and Earth interface. In both cases, this enabled scholars to move more quickly in developing their projects and saved them time and money in the process. The clear downside, and something that was voiced during the workshop discussions, was the fact that Google has no long-term vested interest in the support of any of these projects, and these particular tool-sets could disappear if the fortunes of Google changes significantly. Although KML is open, Google's APIs are not, and the advantages in cost and speed of development in the use of these Google tools are to be weighed against the lack of control over the sustainability of these tools.

Adobe's Flash was the third most common tool that scholars at the workshop used in their work, usually for the translation of GIS work into a web-ready format specific to particular research needs. Much like KML filtered through Google's platforms, applications built on top of Flash are being created by various scholarly projects in order to construct platforms upon which historical visualization work can be more effectively shared and disseminated online. These efforts are invariably more labor and cost-intensive than using Google's prefabricated platforms, but they are also more customizable than what Google makes available and therefore can be more carefully calibrated to the questions and needs of a particular researcher. Bill Ferster's presentation, for example, delineated how a Flash-based application might incorporate GIS shapefiles into a series of historical visualizations that can be shared widely online.

In all cases, the most commonly used tools were proprietary (ArcGIS, Flash, Google's APIs) or associated with a for-profit entity (KML with Google). As such there are currently a number of significant obstacles inherent in sharing historical data stored in such formats and shared on such platforms. There are few platforms available to scholars that have been developed specifically for the sorts of questions that humanities and social science researchers ask. The most widely-used exceptions to this would be the tool-sets developed by MIT's Simile Project (specifically Timeline and Timeplot), although both of those tool-sets showed up only occasionally in the projects discussed at the workshop.

Technical areas for future research identified at the workshop covered a range of topics from data development needs, to storage methods, to software enhancements. In the area of data development there was widespread interest in encouraging the development of "framework" type layers through time, including political boundaries,

place names (gazetteers), vegetation, transportation, hydrography, etc. to enable more detailed analysis of various topics and to facilitate comparative studies. There is also a need for advances and standardization of database schemas and ontologies that relate to and allow the linking of textual, numeric and visual data. Advances in software development that were identified include the development of more dynamic GIS that can handle processes better. The research promise of a distributed network of systems was discussed, with several participants calling for better ways to discover and utilize distributed data, tools, analytical processes, and annotations that are contributed by multiple users of a system. Such systems should allow for the capturing of queries and data exploration as people are working with systems to build analytical stories. A better understanding and methods of linking nested scales of analysis were also thought to be important. Some specific utility applications that were identified were automated georeferencing of scanned maps, automated feature extractions, and temporal editing tools for KML, and other data formats.

The importance of metadata was also discussed at the workshop in detail. The consensus was that this should go beyond merely describing the source and method of producing a data set to tracing how the builders or users of a system have queried the systems, made choices, in order to follow the logic of the narrative that is told, as well as to let people change choices that were made and come up with their own narrative. There is also a need to address the issue of metadata's role in "archiving" online resources for future exploration. In addition to making data available as formats and media change, people should also have access to the logic of systems in order to fully understand the data that went into and the output from such systems.

LACK OF DATA-SHARING

One of the primary challenges holding back advances in historical visualization research, as identified during the workshop, was the lack of data-sharing among historical projects. That is, nearly every project maintained the historical data it was using for its visualizations in a particular format based on the unique needs of that particular project. A given project, for example, might store census and voting data in a particular way that differs significantly from how another project might store or format the same data (probably because different projects ask different questions of the data, and therefore have different needs for its storage and formatting). Thus if multiple projects use the same set of data (such as the U. S. census returns), they are nearly always going to create multiple versions of that same set of data, each customized to a particular project and therefore unable to be shared with other projects. The result is that historical data tends to be digitized into unique datasets that nearly always remain solitary silos, rather than datasets that can be widely shared and disseminated among other interested scholars.

As discussed in detail at the workshop, this is a common and far-reaching problem among those working in historical visualization research. A given researcher working in the field must invariably download necessary datasets from multiple sources and then translate them into new formats that meet the requirements of their own particular research. This is a time-intensive, and therefore expensive, endeavor. The process also usually creates a new set of data (one that combines multiple datasets into a new one that has value for having combined disparate information) that is also in a format that is unique enough to be difficult to share. The result is that scholars are not able to access common datasets (again, census and voting returns being some of the most

obvious of those widely used in numerous visualization projects) available on various servers and access them on-the-fly through something like an API. The ability to do so—to grab datasets available on various servers and then immediately translate them into the forms needed for your own project, without having to download and manipulate them on a local machine—would greatly accelerate the ability of scholars to develop new historical visualization projects.

There are, in fact, standards that exist for such interoperability. As discussed in detail at the workship, the Open Geospatial Consortium (OGC) and the Open Geospatial Consortium Interoperability Institute (OGCii) have been developing such standards for sharing GIS data for some time, and they continue to develop and promote such standards as a means of promoting spatial research among scholars. One of the biggest challenges, however, seems to be a pervasive lack of awareness of such standards among scholars working with and creating historical visualization datasets.

While workshop participants were asked specifically to address the use of distributed systems, it became apparent that little has actually been accomplished to date to integrate and harness the exciting visualization work that is going on in ways that make it easy for people to integrate and visualize data on different systems on the Internet. Part of the reason for this is that most of the work presented at the workshop was project focused and the projects did not require the use of distributed data stores. Where data was acquired from multiple sources it was typically processed locally before being analyzed and visualized. Another aspect of the lack of work in this area is the relatively recent development of technologies that can facilitate visualization from

distributed data stores and that this work is going on in niche areas typically removed from humanities scholars

The problem of interoperability, and promoting the awareness of existing standards and the development of new ones, emerged as one of the primary challenges facing scholars interested in the visualization of historical datasets.

SUBSEQUENT WORK AT THE UNIVERSITY OF RICHMOND AND JAMES MADISON UNIVERSITY

At the conclusion of the workshop, teams at the University of Richmond and James Madison University worked to develop and further explore themes and ideas identified during the workshop itself.

University of Richmond

At the University of Richmond, this work was undertaken at the Digital Scholarship Lab (DSL), a humanities-focused research lab aimed toward advancing disciplines such as history through digital technology. The DSL attempted to extend the lessons learned at the workshop through two specific endeavors:

(1) Survey of projects available online that incorporate visualizations of historical datasets. We wanted to test whether the sampling of projects presented at the workshop was, indeed, representative of the work currently available online. So we conducted an informal survey of projects currently presented online, cataloging a sample of around one hundred online projects that incorporate visualizations of historical datasets in one capacity or another. We conducted this survey during the late spring and summer of

2009, cataloging the sites surveyed into "Appendix 4: Sample Survey of Historical Visualizations Online."

The results of this survey confirmed the patterns we had identified during the workshop. Although it was sometimes difficult to decipher what technology had been used to create the visualizations in particular projects, when we could learn about their methodology the same patterns emerged. ArcGIS served as the standard in assigning data to a particular geography, with KML, Google's platforms, and Flash serving as the primary means of developing methods of disseminating the work of these projects and their historical visualizations online. Similar to the workshop itself, there were various exceptions (such as incorporations of MIT's Simile Project tools). Yet the overwhelming proportion of those projects adapted what appear to have become the standard tools in the field: ArcGIS, KML/Google, and Flash.

The survey also further confirmed the widespread interest in the use of visualizations to make sense of large sets of historical data. Some of the most widely imitated sets of historical visualizations noted in the survey come from the graphics team at the *New York Times* online edition, where they have used Flash and GIS to deliver compelling visualization of various historical phenomenon as they changed over both time and space. Other projects seek to use visualizations to comprehend patterns embedded in large datasets that are becoming ever-more readily available, such as census and voting returns as they changed over time.

(2) Further development of historical visualizations that attempted to deal with incorporating the three toolsets most commonly identified in the workshop, ArcGIS, Google's KML and mapping platforms, and Flash.

Much of this mapping and visualization work took place within the context of work preformed on the DSL's on-going project, *History Engine: Tools for Collaborative Education and Research* <http://historyengine.richmond.edu>. This project collates historical narratives written by undergraduates in classrooms across the country. The historical narratives (which we call "episodes") each have timeframe and location metadata assigned to them, so we had been experimenting with developing methods of mapping and visualizing that historical data across both time and space. Building on the discussions at the workshop, we sought to create new visualizations of these sets of information. (This work also built off previous work preformed at the Digital Scholarship Lab at the University of Richmond, specifically with the development of *Voting America: United States Politics, 1840-2008* <americanpast.richmond.edu/voting/>.)

- Flash Map for Browsing Historical Data: <historyengine.richmond.edu/map/>. This mapping interface takes GIS shapefiles and translates them into a format that can be displayed online through a Flash-based interface. This work was both expensive and laborious, largely because we had to replicate in Flash many of the capabilities that exist in ArcGIS in order to make those capabilities available online. The results, however, were rather impressive—a malleable interface that enables the user to quickly, efficiently, and succinctly manipulate large amount of historical data that is being pulled from a constantly updated database of student historical narratives. Flash also enabled our project team to demonstrate

change over time effectively, and to customize the interface directly toward the needs of our particular project.

- Google KML interface for Browsing Historical Data: <http://historyengine.richmond.edu/location>. We also created a KML version of our browsing interface that relied on Google's mapping platform. In this we translated GIS files into KML, then adapted the Google tools from the mapping API to create a new interface that also pulled from the constantly updated database of student historical narratives. Rather than attempt to replicate many of the capabilities of ArcGIS, this effort built upon Google's existing platforms and tools. This approach was, therefore, much more cost-effective than the earlier efforts at the Flash map, and was accomplished on a much faster timetable. There was a great deal less that we could customize in this approach (since in Flash we could create anything we wanted, whereas with Google's tools we had to chose from existing capabilities), but the results remained quite satisfying.

Another example of a DSL project working to incorporate GIS and KML in analyzing historical datasets online is the *Redlining Richmond* project <http://americanpast.richmond.edu/holc/>. This project sought to take data about the geography of the city of Richmond during the 1930s and the efforts of the Home Owners' Loan Corporation (HOLC) during the New Deal to determine which areas were eligible for federal loans. The work of assigning historical data to locations was preformed in ArcGIS, as it proved to be the most effective and accurate method for doing so. These GIS shapefiles, however, were translated into KML and incorporated into an interactive

map using Google's mapping API. The result is a highly effective interactive map of historical data that was generated quickly and easily disseminated online.

Project experiments reinforced central ideas voiced among participants at the workshop: the precision of ArcGIS to locate geospatial information remains unsurpassed among available toolsets for such work. Yet KML and Flash offer some of the most effective means for disseminating such work online. Flash offers more flexibility in the creation of an online interface, while KML and Google's toolsets offer greater speed and efficiency in creating and completing such projects.

James Madison University

Work at James Madison University included working on the white paper with the University of Richmond, and on researching, documenting, and analyzing tools and standards identified at the workshop and through subsequent exploration. Given the interest in KML and its ability to encode temporal information, faculty and students at JMU utilized Google Earth (http://earth.google.com/) and ArcGIS Explorer (http://www.esri.com/software/arcgis/explorer/index.html) to view multiple time-enabled KML datasets simultaneously. Both viewers were able to display the files and provide a timeline tool to visualize the data through time; however some of the files did not display properly in ArcGIS Explorer. We were not able to determine if the files that were not viewable in ArcGIS Explorer were improperly formatted or if there were bugs in the software. Two additional issues emerged from this work: (1) no easy and systematic method of discovering time-enabled KML files and what time period they represent, and (2) the limited functionality of the temporal tools available in both packages.

The remainder of the effort focused on other data and interoperability standards related to building standards-based and internet-accessible servers in support of spatial and temporal visualization. An existing international effort has been underway for some time to establish standards and best practices in the development of spatial data infrastructures (SDI), and is being championed at the international level by the Global Spatial Data Infrastructure Association (http://www.gsdi.org/). SDIs are designed to allow for easy and standard methods of discovering and disseminating geospatial data across multiple organizations. The GSDI organization includes many international partners and has developed a "cookbook" (http://www.gsdi.org/gsdicookbookindex) for organizations wishing to develop SDIs that integrate with others across the globe. The cookbook is based on internationally accepted standards primarily developed through OGC and ISO processes. Affiliated organizations are also working on a minimum "best practices" designation that identifies the core elements needed in an SDI implementation (see http://www.giknet.org/bestpractice.php).

OUTCOMES:

Some of the most valuable outcomes were the cross-discipline discussions that emerged during the workshop, which will likely yield fruit in the field over the coming years in the form of new collaborations and endeavors. There were, however, a number of specific outcomes that came directly out of the two-day workshop and the conversations that began during its presentations and discussions:

(1) The Open Geospatial Consortium (OGC) is seeking to develop a temporal gazetteer in order to facilitate the sharing and rapid development of historical data

visualizations. This was a key need identified at the workshop, as there are few resources available for the standardization of place-names and locations across time. Peter Bol emphasized this matter in particular and found himself in agreement with a large number of people at the workshop. The members of the OGC present, David Arctur and Phillip Dibner, proposed during one of the discussion periods that the OGC perhaps could organize an effort to develop interoperability standards for a temporal gazetteer that could then facilitate such research by historians seeking to harness the power of GIS.

Since the workshop, the OGC has worked to push forward in the development of a temporal gazetteer. Initial efforts to develop the project under an OGC test-bed activity called OWS-7 did not survive initial discussions due to budget limitations. Currently, however, a standards working group of the OGC considering changes to WFS-G (Web Feature Service, Gazetteer profile) is taking initial steps toward the development of a temporal gazetteer. An on-going discussion, moreover, continues among an email group established at the workshop itself, geared toward this specific goal and moderated by the OGC, with the goal of solving this particular problem identified during the workshop discussions.

(2) The Open Geospatial Consortium Interoperability Institute (OCGii) is also actively moving forward on the development of a temporal gazetteer standard. According to Phillip Dibner, the executive director of the OGCii and a participant of the workshop, the OGCii has been pushing forward on possibly hosting "a workshop that addresses this directly, and incorporates a broad array of interested communities not currently involved with the OGC, including the academic History community. There are

other groups who need to be engaged in such developments, and we envision this as an opportunity to get them all together."

(3) The survey of historical visualizations online. As discussed above, this survey reinforced patterns observed during the workshop itself (in terms of the dominance of ArcGIS, KML, Google, and Flash as the tools-sets used in historical visualization research). The sites surveyed can be seen in "Appendix 4: Sample Survey of Historical Visualizations Online."

(4) Experiments conducted at the University of Richmond and James Madison University in developing historical visualizations using the dominate software identified during the workshop, as discussed above.

(5) Workshop co-organizer James Wilson, workshop participant David Bodenhamer, and Ian Gregory (Lancaster University, UK) included questions on "visualization" in a recent survey they put together as part of a Spatial Literacy in Teaching (SPLINT, see http://www.le.ac.uk/gg/splint/) fellowship on "GIS in the Humanities: Towards an educational strategy in Britain and America" (see http://www.hgis.org.uk/splint/). The workshop and survey results are currently being analyzed.

RECOMMENDATIONS FOR FUTURE WORK

In sum, we can make several overarching recommendations for future work in historical visualizations that will, we hope, push the field forward and enable a much broader range of scholars to engage in such research. These conclusions emerged from

workshop presentations and discussions and were reinforced by subsequent explorations by the project team.

(1) In order to widen the number of scholars engaging in historical visualization work, we need the development of much more accessible toolsets for GIS work beyond the ESRI suite of tools that can more easily be learned by scholars without a technical background in geospatial analysis and more adaptable to some of the research needs unique to the humanities disciplines.

(2) In order to promote the analysis of change over time, we need the development of more sophisticated toolsets for animating historical over a time-series, beyond what ArcGIS currently makes available. This appears to be an underdeveloped area of current software (for which scholars usually adapt Flash-based applications), although both KML and ArcGIS are increasing their capabilities in these areas.

(3) In order to ensure the transparency of the scholarship that emerges from historical visualization research, we need the development of more robust standards for dealing with ambiguity and gaps in historical datasets, so that people who create and read these visualizations will be fully aware of the state of the data and produced a given visualization.

(4) In order to promote the sharing of historical datasets, we need the further development (and increased awareness among scholars) of interoperability standards for the sharing and disseminating of historical datasets in manners that will promote the sharing of various GIS and other information sets being created by various scholars. In other words, the further development of standards (such as the OGC continues to do) that

will enable the sharing and repurposing of these datasets, and making scholars fully aware of them.

(5) Based on the examination of existing international efforts to develop SDIs based upon internationally developed and acceptable standards we feel that researchers interested in developing internet-based systems for temporal geospatial data and tools for the humanities should look to build upon existing and engage in future developments of SDI and geospatial interoperability efforts to enhance their applicability for temporal and humanities related data and analysis. (Details on the most relevant geospatial and temporal standards and tools that support some of the standards will be provided on the project website: http://dsl.richmond.edu/workshop).

Work in these areas has already begun, and we believe that the collaborations that are emerging from this project's workshop will help fulfill these goals and thereby move the field of historical visualization forward in powerful new ways.

APPENDIX 1: CALL FOR PAPERS

The digital revolution has made massive amounts of historical and social science data available to scholars in electronic formats, and this phenomenon is opening new possibilities for exploring the human past. The ability to plot historical processes embedded in these datasets using mapping and visualization tools holds remarkable promise for providing scholars new insights into old questions. Yet significant obstacles currently prevent scholars from sharing their geospatial data with one another, and thus from full taking advantage of the potential of visualization techniques.

To address this, scholars and practitioners from multiple disciplines (geography, history, geographic information science, computer science, graphic arts, etc.) are invited to submit proposals for presentations at a two-day workshop (funded by the National Endowment for the Humanities) that will focus on two main issues:

How can we harness emerging cyberinfrastructure tools and interoperability standards to visualize, analyze, and better understand historical events and processes as they spread out across both time and space?

How can user-friendly tools or web sites be created to allow scholars and researchers to animate spatial and temporal data housed on different systems across the Internet?

We seek 2-3 page proposals for 20-30 minute presentations that describe ongoing projects, address these questions, and outline a view for future research and experimentation. We invite proposals from all backgrounds, and relevant topics might include: historical GIS applications, cartographic animation, analyzing and visualizing temporal data, service oriented architecture, web-mapping and interoperability standards, data and metadata standards, open-source and commercial applications.

The workshop will center on in-depth discussions among 10-20 participants in roundtable format. The first day will be devoted to individual presentations; the second day to discussions about the workshop's main questions, and describing what should be the future of this work. Travel scholarships will be available to invited participants.

For more information or to submit your proposals, contact the conference organizers at:

Andrew J. Torget, University of Richmond, atorget@richmond.edu , 804-484-1636
James W. Wilson, James Madison University, wilsonjw@jmu.edu , 540-568-2757
Proposals are due December 15, 2008 via email to the conference organizers, and invitations for participation will be sent out by December 31, 2008. The workshop will be held at the University of Richmond, February 20-21, 2009.

APPENDIX 2: LIST OF PARTICIPANTS

Project Directors

Andrew J. Torget was the director of the Digital Scholarship Lab at the University of Richmond at the time of the workshop. Today he is an assistant professor of history at the University of North Texas, where he leads development of a number of digital projects focusing on visualizations of historical processes. Torget is director of Voting America: United States Politics, 1840-2004, the Texas Slavery Project, and the History Engine: Tools for Collaborative Education and Research, as well as the co-editor of two books on the American Civil War.

James W. Wilson is an assistant professor of geographic science at James Madison University, specializing in historical geography, Internet GIS, and cartography. Wilson is on the Advisory Board of the Virginia Geographic Information Network (the state GIS coordinating body), and the secretary of the Historical Geography Specialty Group of the Association of American Geographers. His article "Historical and Computational Analysis of Long-Term Environmental Change: Forests in the Shenandoah Valley of Virginia" appeared in a special issue of Historical Geography devoted to Historical GIS (Vol. 33, 2005).

Project Advisory Board

David Arctur is President and Chief Technology Officer of the Open Geospatial Consortium Interoperability Institute (OGCii), a non-profit scientific and educational organization dedicated to continued improvements in worldwide application of interoperable geoprocessing technologies and spatial data. Arctur has previously been a Data Architect, Product Engineer, and Interoperability Engineer at ESRI; was the Chief Scientist at Laser-Scan, Inc.; and a Senior Research Associate at the University of Florida. He is the co-author of Designing Geodatabases: Case Studies in GIS Data Modeling (ESRI Press, 2004).

Edward L. Ayers is the president of the University of Richmond and a historian of the American South. Ayers has been involved in numerous digital humanities projects, most notably as the director of the award-winning digital archive The Valley of the Shadow: Two Communities in the American Civil War. He also co-authored a born-digital article, "The Differences Slavery Made: A Close Analysis of Two American Communities," which used GIS mapping to examine the role slavery played in the outbreak of the American Civil War, and appeared in the December 2003 issue of the American Historical Review.

Peter K. Bol is the director of Harvard University's Center for Geographic Analysis and the Charles H. Carswell Professor of East Asian Languages and Civilizations. Bol led Harvard's university-wide effort to establish support for geospatial analysis in teaching and research, and directs the China Historical Geographic Information Systems project, a collaboration between Harvard and Fudan University in Shanghai to create a GIS for 2000 years of Chinese history.

David Schell serves as Chairman of the Board of the Open Geospatial Consortium Inc., which he founded in 1994 with both public and private sector support to evolve "OpenGIS" into a global standard for interoperable geoprocessing. Schell is primarily responsible for directing OGC's Board of Directors operations and since 2004 he has served as Chairman and CEO of the OGC.

Terry A. Slocum is Chair of the Department of Geography at the University of Kansas. Slocum is lead author of Thematic Cartography and Geovisualization (now in its third edition) and has published on geography and visualizations in numerous journals, including Cartography and Geographic Information Science, Cartographica, Journal of Geography, Annals of the Association of American Geographers, The Professional Geographer, and The British Cartographic Journal. From 1999 to 2002, he served as editor of Cartography and Geographic Information Science.

Richard White is the Margaret Byrne Professor of American History at Stanford University, where he directs Stanford's Spatial History Lab and its effort to create new tools for visualizing historical development. His current digital humanities project, How the West Was Shaped, is developing a large database and computer graphics tools to study and represent visually how people's experience of space and time was dramatically shaped by railroads in the North American West during the nineteenth century.

Workshop Participants:

Rafael Alvarado is the principle information architect for House Divided Project, a comprehensive archive of primary and secondary sources relating to the years leading up to the American Civil War. He has been active in the digital humanities since early 1990s when he created the Mayan Epigraphic Database Project at the Institute for Advanced Technology in the Humanities (IATH). In 1997 he traveled to Princeton University to become Coordinator of Humanities and Social Sciences Computing, where he established the Consortium for the Development of Digital Collections, the Educational Technologies Center, and the Humanities Computing Research Support group. Currently at Dickinson College, Rafael has also developed software for numerous digital humanities projects.

Nathaniel Ayers is the Digital Scholarship Lab's programmer analyst at the University of Richmond, serving as the head of the Lab's historical visualization work on projects such as Voting America. A graduate of Virginia Commonwealth University, Nate has done programming and visualization work for the University of Virginia.

David J. Bodenhamer is professor of history and founding executive director of the Polis Center at Indiana University Purdue University, Indianapolis. During his tenure, the center has developed over 600 projects, with grant and contract funding of over $55 million. In addition, Polis has expanded its programmatic focus from Indianapolis and Central Indiana to state, regional, national, and international partnerships and projects. An active researcher, Bodenhamer is author or editor of eight books, with two books on the spatial humanities forthcoming in 2009 and 2010. He has made over 65 presentations to audiences on four continents on topics ranging from legal and constitutional history to

the use of GIS and advanced information technologies in academic and community-based research. He also has served as strategic and organizational consultant to universities, government agencies, and not-for-profit and faith-based organizations across the U.S. and in Europe.

Jon Christensen is a Ph.D.candidate in the Department of History and an associate director of the Spatial History Project of the Bill Lane Center for the American West at Stanford University. He is a Distinguished Departmental Scholar for Academic Year 2008-2009, supported by a Mellon Foundation Dissertation Fellowship, and was honored with a Prize for Excellence in First-Time Teaching in 2005-2006. Department of History, Stanford University. He is coordinating "Tooling Up for Digital Histories," a collaboration between the Spatial History Lab, the Computer Graphics Lab, and Stanford Humanities Center, supported by grants from the Presidential Fund for Innovation in the Humanities at Stanford. Visualizing the past through digital historical sources and spatial analysis has been the key to his own dissertation, "Critical Habitat," a history of ideas, narratives, science, land use, and practices of conservation and extinction of a species in time and space. Web sites: http://stanford.edu/~jonallan/ and http://spatialhistory.stanford.edu.

Alan Craig has focused his career on the interface between humans and machines. He has been involved in many different capacities related to scientific visualization, virtual reality, data mining, multi-modal representation of information, and collaborative systems during his career at the National Center for Supercomputing Applications where he has worked for the past twenty years. Craig is co-author of the book Understanding Virtual Reality, published by Morgan Kaufmann Publishing, and author of the forthcoming book, Using Virtual Reality.

Phillip C. Dibner is the Director of Research Programs for the OGC Interoperability Institute (OGCii), the research and educational affiliate of the Open Geospatial Consortium (OGC). Dibner has been involved with the OGC since its inception, where he has managed technical integration and coordinated demonstrations for testbeds, interoperability experiments, and pilot implementations, in remote collaboration with participants throughout Europe, North America, and Australia. He also established and continues to chair the OGC Earth Systems Science Domain Working Group (ESS DWG). Trained as an ecologist at the Yale School of Forestry and Environmental Studies, Dibner has had field experience throughout the continental United States. Prior to his involvement with the OGC, he joined the Silicon Valley technology boom of the 1980s and '90s, where he worked on operating systems and network protocols, while pursuing his interest in environmental and ecological data acquisition and analysis.

Max Edelson is Associate Professor of History at the University of Illinois at Urbana-Champaign. His first book, Plantation Enterprise in Colonial South Carolina, examines agriculture, economy, and environment in the making of the Carolina Lowcountry's early plantation landscape. His current research investigates cartography and empire in eighteenth-century British America. In collaboration with the Institute for Computing in Humanities, Arts, and Social Science (I-CHASS) at the National Center for

Supercomputing Applications at Illinois, he received an NEH Level I Digital Humanities Start-Up Grant to create the Cartography of American Colonization Database (CACD).

Bill Ferster is senior scientist at the University of Virginia with a joint appointment with the Center for Technology and Teacher Education at the Curry School and the Virginia Center for Digital History in the College of Arts and Sciences. He has founded numerous companies including West End Film, developer of the first PC-based 3D animation system, EMC, developer of the first digital nonlinear editing system which received an EMMY Award in 1993, and StageTools, the leading developer of image animation tools.

Charles van den Heuvel is senior researcher for the Virtual Knowledge Studio for the Humanities and Social Sciences of the Royal Netherlands Academy of Arts and Sciences, where he leads the research project "Paper and Virtual Cities. New methodologies for the use of historical sources in virtual urban cartography," with the Department of Information Science at Groningen University. (1956) finished his study Art History and Archeology at Groningen University with a specialization in the history of architecture, town planning and planning sciences in 1982. He received his Ph.D. from the University of Groningen in 1991, writing his dissertation on the dissemination of knowledge of Italian engineers in the Netherlands and their role in the introduction of the "renaissance" culture in the Netherlands. Since then he worked as a senior-researcher for the universities of Groningen, Utrecht, Maastricht and research institutes, such as the Maastricht McLuhan Institute.

Matthew Koeppe is Director of GIScience Programs at the Association of American Geographers, where he coordinates many of the AAG's GIS-related activities in the areas of education, outreach, international programs, and public policy. Matthew received his PhD in geography from the University of Kansas in 2005. His research background and interests include environment and development in the Brazilian Amazon, tropical frontier expansion, the social and political aspects of land cover classification, and the geography of food production and consumption.

Sorin Adam Matei is known for applying, from a cross-analytical perspective, traditional statistical, GIS, and spatial methodologies to the study of information technology and social integration. He has conducted a number of studies on the social and cognitive impact of location aware systems deployed in real or virtual environments. His current research is particularly focused on the role of spatial indexing on learning in location aware situations and on the role of physical affordances in structuring location aware communication experiences. The experimental work he conducted at Purdue University's Envision lab indicates that there are some benefits for information acquisition in location aware situations. In addition, he has conducted large-scale multidisciplinary surveys of communication technology use in local communities both in the United States and in Europe. His research was funded by Motorola, Kettering Foundation, University of Kentucky, and Purdue University and was recognized by various professional organizations with paper and research awards. His teaching makes use of a number of software platforms he has codeveloped, such as Mindmeld.

Mano Marks is a Developer Advocate with Google, helping people place their content in Google Earth and Maps. He has a Masters in History from Columbia and a Masters in Information Management and Systems from UC Berkeley. He is very interested in the intersection between data, visualization, and communication.

Worthy N. Martin received his Ph.D. in Computer Science from the University of Texas-Austin in 1981. He then joined the University of Virginia in 1982 as a professor of Computer Science. He is the author or co-author of 55 papers. His primary research interest is dynamic scene analysis, i.e., computer vision in the context of time-varying imagery, as well as the fundamental concepts involved in machine perception systems composed of independent processes operating in distributed computing environments and cooperating to form interpretations of image sequences.

Robert K. Nelson is the Digital Scholarship Lab's associate director, overseeing historical visualization work on the History Engine and the Text-Mapping projects. A graduate of William and Mary's American Studies Ph.D. program, Rob is a historian of nineteenth-century America.

Scott Nesbit is a Doctoral Fellow at the Institute for Advanced Studies in Culture and a PhD candidate in the History Department at the University of Virginia. His dissertation examines the politicization of the idea of forgiveness in the American Civil War era. He is co-creator and an associate director of the History Engine and has managed for several other online projects at the Virginia Center for Digital History.

J. B. Owens is Professor of History and Director of the Geographically-Integrated History Laboratory at Idaho State University. He currently serves as co-Project Leader of a multidisciplinary, multinational research project he created for the European Science Foundation's EUROCORES (European Collaborative Research) Scheme's program "The Evolution of Cooperation and Trading" (TECT). The title of his project is "Dynamic Complexity of Self-Organizing Cooperation-Based Commercial Networks in the First Global Age" (acronym: DynCoopNet), and the work involves researchers from sixteen countries on five continents (including co-authors of his position paper for the "Visualizing the Past" workshop). Before creating the DynCoopNet Project, Owens held consecutive fellowships from the National Endowment for the Humanities and the John Simon Guggenheim Memorial Foundation. Owens' research has focused on the cultural, economic, and social contexts shaping the exercise of political authority in the Kingdom of Castile during the period 1400-1700.

Peter Pulsifer is a research associate at the Geomatics and Cartographic Research Centre, Department of Geography, Carleton University in Ottawa, Canada. Pulsifer's research is focused on creating new knowledge, methods and tools in support of integrating geographic data, information and knowledge for education and decision support. His research incorporates several major, current themes in Geomatics research including Web-based mapping for education and decision support, modeling and integration of geographic information, and the ontological foundations of visualization and representation of geographic phenomena. Peter has been very active in research related to

information management and the development of on-line atlases for the polar regions. He applies an collaborative. interdisciplinary to research and has worked closely with human and physical geographers, cartographers, psychologists, cognitive scientists, computer scientists, anthropologists and cultural theorists.

Carsten Roensdorf is an expert geographic data management and currently holds the position of Corporate Data Manager at Ordnance Survey, Great Britain's National Mapping Agency. In this role he is responsible for the integrity of the National Geographic Database, the repository for consistent, high detailed geographic base data in Great Britain. Carsten is a trained geodesist and has created, managed and utilised geographic uses in central and local government, utilities, mobile telecoms as well as land management. He is an active participant in the development of geographic information standards in the Open Geospatial Consortium and led the standardisation of CityGML, a standard to represent cities in multiple dimensions, in 2008.

Kurt Rohloff is a Scientist in its Information and Knowledge Technologies department at BBN Technologies, where his areas of technical expertise include computational modeling, control and decision systems, distributed resource management, and software reliability. Kurt's recent research focus has been developing automated methods to identify quantifiable patterns in highly multi-dimensional data with a particular focus on patterns that precede nation-state instability as part of the externally-funded ICEWS program. Kurt's other research focuses at BBN have been in applying notions of control theory for the increased performance and reliability of interacting, distributed computational modeling systems. Kurt was previously affiliated with the Coordinated Science Laboratory (CSL) at the University of Illinois, Urbana-Champaign, the Center for Mathematics and Computation (CWI) in Amsterdam, the Netherlands, and MIT's Lincoln Laboratory in Lexington, MA.

Erik Steiner is a visiting scholar at Stanford University, where he is the director of the Spatial History Lab. A recognized leader in the design of dynamic mapping applications, he has most notably led the development of the Atlas of Oregon CD-ROM and the Interactive Nolli and Vasi Websites of Rome. Erik has a permanent appointment in the InfoGraphics Lab in the Geography Department at the University of Oregon.

Josh Wall is a managing consultant for Information Strategies (www.infostrat.com) a Washington DC based Microsoft Gold Partner. Information Strategies was chosen by Microsoft to be one of a select group of partners to build solutions for Microsoft Surface, their innovative new multi-touch device. Josh and his team have worked closely with the Microsoft Virtual Earth team to build the next generation of GIS solutions that leverage the multi-touch technology in Microsoft Surface.

Chris Weaver is Associate Director of the Center for Spatial Analysis and Assistant Professor in the School of Computer Science at the University of Oklahoma. Weaver holds a B.S. in Chemistry and Mathematics from Michigan State and an M.S. and Ph.D. in Computer Science from Wisconsin. Chris' grand tour of academic research so far includes analytical chemistry, cognitive psychology, operating systems, databases,

human-computer interaction, and geographic information systems. He was recently a Research Associate with the GeoVISTA Center in the Department of Geography at Penn State, where he was also a founding member and core investigator with the North-East Visualization and Analytics Center.

Hadley Wickham is an assistant professor of Statistics at Rice University. He is interested the use of graphics to reveal interesting and unexpected features of data, as well as practical tools to make dealing with real-life data easier. He won the John Chambers Award for Statistical Computing for his work on the ggplot and reshape R packages.

May Yuan is Brandt Professor, Edith Kinney Gaylord Presidential Professor and Associate Dean of Atmospheric and Geographic Sciences and the director of Center for Spatial Analysis at the University of Oklahoma. May's research interest is in temporal GIS, geographic representation, spatiotemporal information modeling, and applications of geographic information technologies to dynamic systems. Her research projects center on representation models, algorithms for spatiotemporal analysis, and understanding of dynamics in geographic phenomena, such as wildfires, rainstorms, air-pollution plumes, and behavior and activities in complex social systems. She explores multiple perspectives of dynamics, analyzes the drivers and outcomes of geographic dynamics, extracts spatiotemporal patterns and behavioral structures of dynamic systems, and draws insights into the system development and evolution to derive an integrated understanding, interpretation, and prediction of activities, events, and processes in dynamic geographic systems.

Jeanette Zerneke is the Technical Director for the Electronic Cultural Atlas Initiative (ECAI). In that role Jeanette works with a diverse group of technology experts to develop tools and methodologies that support ECAI's mission. ECAI is a global collaboration among humanities scholars, librarians, cultural heritage managers, and information technology researchers. ECAI's mission is to enhance scholarship by promoting greater attention to time and place. Jeanette's work involves developing infrastructure, programs, methodologies, working groups, and training workshops to support ECAI affiliates in project development and integration. Jeanette works directly with project teams to develop web sites and ePublications highlighting the growing use of new technologies to present cultural information in innovative ways.

APPENDIX 3: WORKSHOP SCHEDULE OF EVENTS

DAY ONE (February 20)
7:45am and 8:15am: Shuttles from hotel to Jepson Alumni Center

8:30am: Breakfast

9:00am: Andrew Torget and James Wilson: Welcome, introductions, and opening remarks

10:00am: Session 1

- J. B. Owens, "Visualizing Historical Narratives: Geographically Integrated History and Dynamics GIS
- Jeanette Zerneke, "From Historical GIS to Seeing History"
- May Yuan and Chris Weaver, "Visual Analytics and Applications to Historical Data"
- Discussion

12:00pm: Lunch

- Josh Wall, "Microsoft Surface and Virtual Earth"

1:30pm: Session 2

- Rafael Alvarado, "The Semantic Web as a Tool for Visualization and Collaboration: The House Divided Project and the Underground Railroad"
- Kurt Rohloff, "CWEST: Disruptive Integration of Computation Technology for Data Analysis and Visualization"
- David Arctur and Phillip Dibner, "Interoperability, Knowledge Integration, and the Study of Historical Processes"
- Discussion

3:30pm: Afternoon break

4:00pm: Session 3

- David Bodenhamer, "Visualizing Complex Data in an Online Historical GIS: Twentieth Century Religious Adherence Data as a Testbed"
- Peter Pulsifer, "The Role of Cybercartography in Exploring, Visualizing and Preserving the Past"
- S. Max Edelson and Alan Craig, "Rendering Digital Maps: Using and Displaying Images in the Cartography of American Colonization Database"
- Discussion

DAY TWO (February 21)
7:45am and 8:15am: Shuttles from hotel to Jepson Alumni Center

8:30am: Breakfast

9:00am: Session 4

- Peter Bol, "People and Places: Computing China's Past"
- Jon Christensen, "Tooling up for Spatial History Projects"
- Charles van den Heuvel, "Visualizing Historical Evidence and Experience: Two Projects Around Early Modern Manuscript Maps and an Experimental e-Humanities Lab"
- Sorin Matei, "Visible Past: Where Information Searches for You"
- Discussion

11:30am: Lunch

- Mano Marks, "Using Google Geo Technologies to Visualize Spatially Located Data"

1:00pm: Session 5

- Hadley Wickham, "Visualizing Data with R"
- Carsten Ronsdorf, "Integration of Historic Data Fragments on the Basis of CityGML"
- Bill Ferster, "The Emancipation of Data: A Call to Action"
- Discussion

2:30pm: Afternoon break

3:00pm: Andrew Torget and James Wilson: Wrap-up discussion

APPENDIX 4: SAMPLE SURVEY OF HISTORICAL VISUALIZATIONS ONLINE

PROJECT NAME	PROJECT URL	AFFILIATION
The Spatial History Project	http://www.stanford.edu/group/spatialhistory/cgi-bin/site/page.php?id=1	Stanford University (part of the Bill Lane Center for the American West)
Mapping the US Southeast Region during the Civil War	http://gis.harvard.edu/icb/icb.do?keyword=k235&state=popup&topicid=icb.topic35356&view=view.do&viewParam_name=2006%2FCivil_War%2FCivil_War&viewParam_fname=	Center for Geographic Analysis (CGA), Harvard University
Texas Slavery Project	http://www.texasslaveryproject.org	Andrew Torget
Voting America	http://americanpast.richmond.edu/voting	Digital Scholarship Lab, University of Richmond
Hypothetical Redistricting Visualization	http://gis.harvard.edu/icb/icb.do?keyword=k235&state=popup&topicid=icb.topic35356&view=view.do&viewParam_name=2006%2FNJ_Redistricting%2FRedistricting&viewParam_fname=	Center for Geographic Analysis, Harvard University
U.S. County Boundaries	http://maps.cga.harvard.edu/samples/US_Counties.htm	Center for Geographic Analysis, Harvard University
U.S. Congressional District Boundaries	http://maps.cga.harvard.edu/samples/US_CDs.htm	Center for Geographic Analysis, Harvard University
U.S. Metropolitan Statistical Area Boundaries	http://maps.cga.harvard.edu/samples/US_MSAs.htm	Center for Geographic Analysis, Harvard University
The House Divided Project	http://housedivided.dickinson.edu/	Dickinson College
North American Religion Atlas	http://www.religionatlas.org/	The Polis Center, Indiana University Purdue University Indianapolis (IUPUI) [seems to be the main project leader]; The Electronic Cultural Atlas Initiative, University of California, Berkeley; Florida State University
Swine Flu Map	http://www.usatoday.com/news/health/2009-04-27-swine-flu-world-map_N.htm	USA Today
Interactive Time Line	http://www.digitalhistory.uh.edu/timeline/timelineO.cfm	Digital History, University of Houston
The History of Jim Crow	http://www.jimcrowhistory.org/geography/geography.htm	New York Life
AP Economic Stress Index	http://hosted.ap.org/dynamic/files/specials/interactives/_national/stress_index/index.html?SITE=YAHOO&SECTION=HOME (warning, it suddenly says this website doesn't exist anymore)	Yahoo! News, Associated Press
The Geography of Jobs	http://tipstrategies.com/archive/geography-of-jobs/	TIP Strategies
U.S. Drought Monitor	http://drought.unl.edu/DM/MONITOR.HTML	National Drought Mitigation Center
USA National Gas Temperature Map	http://www.gasbuddy.com/gb_gastemperaturemap.aspx	GasBuddy
Dynamic Maps of Bank Card and Mortgage Delinquencies in the United States	http://data.newyorkfed.org/creditconditionsmap/	Federal Reserve Bank of New York, with credit info from TransUnion, LLC
Bank Financial Performance Map	http://banktracker.investigativereportingworkshop.org/banks/	American University School of Communication, Investigative Reporting Workshop
Anthrax at Home	http://www.washingtonpost.com/wp-srv/flash/war/anthrax/anthrax_map.htm	The Washington Post
Geography of a Recession	http://www.nytimes.com/interactive/2009/03/03/us/20090303_LEONHARDT.html	The NY Times
Shaping the West	http://www.stanford.edu/group/spatialhistory/cgi-bin/site/project.php?id=997	Spatial History Project, Standford University
Critical Habitat	http://www.stanford.edu/group/spatialhistory/cgi-bin/site/project.php?id=1001	Spatial History Project, Standford University
Between the Tides	http://www.stanford.edu/group/spatialhistory/cgi-bin/site/project.php?id=1005	Spatial History Project, Standford University
The Civil War in Four Minutes	http://www.idkwtf.com/videos/latest-videos/the-civil-war-in-four-minutes (this is only a website that hosts the video currently. You actually have to purchase the video from BRC, and they've taken it down from YouTube)	BRC Imagination Arts
Twittervision	http://beta.twittervision.com/	Twittervision, Google
American Human Development Index, 2005	http://map.measureofamerica.org/maps.aspx	American Human Development Project
The Mannahatta Project	http://themannahattaproject.org/explore/mannahatta-map/	Wildlife Conservation Society (also uses Google)
Social Explorer	http://www.socialexplorer.com/pub/maps/home.aspx	Social Explorer
Personal World Map	http://www.personalworldmap.org/	Roxana Torre (apparently individually developed)

Mapping History	http://mappinghistory.uoregon.edu/english/modules/html	University of Oregon
Digital History Project	http://www.newmexicohistory.org	New Mexico Office of the State Historian
Bethlehem Digital History Project	http://bdhp.moravian.edu/home/home.html	Reeves Library, Moravian College
Railroads and the Making of Modern America.	http://railroads.unl.edu/about/index.php	University of Nebraska-Lincoln
Political Maps.org	http://politicalmaps.org/digital-history-interactive-timeline-map-of-us-history/	University of Houston
North Carolina Floodplain Mapping Information System	http://floodmaps.nc.gov/fmis/MainMap.aspx	North Carolina Floodplain Mapping Program
World Wars: Genocide Under the Nazis	http://www.bbc.co.uk/history/worldwars/genocide/launch_ani_auschwitz_map.shtml;	BBC
California Labor History	http://calpedia.sfsu.edu/calabor/	San Francisco State University
Aaron Koblin's Flight Patterns	http://www.aaronkoblin.com/work/flightpatterns/	Aaron Koblin (independently developed), with inspiration from the "Celestial Mechanics" project at UCLA
Twittering the Super Bowl	http://www.nytimes.com/interactive/2009/02/02/sports/20090202_superbowl_twitter.html	Matthew Bloch for the New York Times
A Year of Parking Tickets	http://www.nytimes.com/interactive/2008/11/26/nyregion/20081128_PARKING.html	same as above
Electoral Explorer	http://elections.nytimes.com/2008/results/president/explorer.html	same as above
New York Talk Exchange	http://www.aaronkoblin.com/work/NYTE/index.html	Aaron Koblin, Senseable City Lab at MIT
Obama | One People	http://senseable.mit.edu/obama/	Senseable City Lab at MIT
Center for History and New Media	http://chnm.gmu.edu/	Center for History and New Media, George Mason University
Mississippi Flood Map	http://maps.grammata.com/flood.html	"Student work" section of Matthew Bloch's personal website
Evening Flights from Madison, WI	http://maps.grammata.com/evening_flights.html	same as above
When Did Your Country's Jobs Disappear?	http://www.slate.com/id/2216238/	Slate
Immigration Explorer	http://www.nytimes.com/interactive/2009/03/10/us/20090310-immigration-explorer.html?hp	The New York Times
Visualizing the Grid	http://www.npr.org/news/graphics/2009/apr/electric-grid/	NPR
Military Installation Map	http://benefits.military.com/misc/installations/Browse_USMap.jsp	Military.com
Inaugural Words	http://www.nytimes.com/interactive/2009/01/17/washington/20090117_ADDRESSES.html?scp=4&sq=interactive&st=cse	The New York Times
The Ebb and Flow of Movies	http://www.nytimes.com/interactive/2008/02/23/movies/20080223_REVENUE_GRAPHIC.html?scp=10&sq=interactive&st=cse	same as above
New York Times Endorsements Through the Ages	http://www.nytimes.com/interactive/2008/10/23/opinion/20081024-endorse.html?scp=12&sq=interactive&st=cse	same as above
Cars and Trucks Made in the USA	http://www.nytimes.com/interactive/2009/06/19/automobiles/20090619-auto-plants-4.html?scp=15&sq=interactive&st=cse	same as above
Where Homes Are Worth Less than the Mortgage	http://www.nytimes.com/interactive/2008/11/10/business/20081111_MORTGAGES.html?scp=18&sq=interactive%20map&st=cse	same as above
A Growing Detention Network	http://www.nytimes.com/interactive/2008/12/26/us/1227_DETAIN.html?scp=26&sq=interactive%20map&st=cse	same as above
Disappearing Foods	http://www.nytimes.com/interactive/2008/04/29/dining/20080430_LIST_GRAPHIC.html?scp=33&sq=interactive%20map&st=cse	same as above
Campaign Finance Tracker	http://www.usatoday.com/news/politics/election2008/campaign-finance-tracker.htm	USA Today
Finding the Hits, Avoiding the Errors	http://www.nytimes.com/interactive/2008/06/08/travel/20080608_BALLPARK_GRAPHIC.html?scp=29&sq=interactive&st=cse	The New York Times
The Varying Impact of Gas Prices	http://www.nytimes.com/interactive/2008/06/09/business/20080609_GAS_GRAPHIC.html?scp=32&sq=interactive&st=cse	The New York Times
The Atlas of Early Printing	http://atlas.lib.uiowa.edu	University of Iowa

Itinerary of John	http://home.myuw.net/jjcrump/Timelines/itinerary/JohnItinerary.html	J.J. Crump
Comings and Goings: Migration Flows in the US	http://pewsocialtrends.org/maps/migration/	Pew Research Center
SHOW USA	http://show.mappingworlds.com/usa/	Mapping Worlds
SHOW WORLD	http://show.mappingworlds.com/world	Mapping Worlds
An In-Depth Look at USA's Religious Beliefs, Practices	http://www.usatoday.com/news/graphics/2008_pew_religion/flash.htm	USA Today and Pew Forum on Religious and Public Life
GIS For History	http://www.gisforhistory.org	University of Illinois at Chicago
Henry Hudson 400: Celebrating History of Hudson, Amsterdam, and New York	http://www.henryhudson400.com	Cartosoft
True North: Mapping Minnesota's History	http://www.lmic.state.mn.us/ghol/Maps.php	Minnesota Historical Society, institute of Museum and Library Services, Minnesota Management Information Center
Interactive Maps	http://www.goforbroke.org/history/history _historical_maps.asp	Go For Broke National Education Center
Rise and Fall of Jim Crow	http://www.pbs.org/wnet/jimcrow/themap/map.html	PBS
Transparency Timeline	http://www.sunlightfoundation.com/projects/transparency-timeline/	Sunlight Foundation
Casino Map	http://www.lasvegassun.com/history/map/	Las Vegas Sun
The Rise of Data Breach	http://www.voltage.com/solutions/data-breach/index.htm	Voltage Security
Bestiario	http://www.bestiario.org/	Bestiario
Non-Geographic Mapping	http://www.princeton.edu/~ina/maps/non_geographic/index.html	Princeton: International Networks Archive
Telephone Traffic	http://www.princeton.edu/~ina/maps/dynamic/index.html	Princeton: International Networks Archive
Hypermedia Berlin	http://www.berlin.ucla.edu	UCLA
Mapping Foreclosures	http://www.bos.frb.org/economic/dynamicdata/module1/bmap.html#	Federal Reserve Bank of Boston
Oakland Crimespotting	http://oakland.crimespotting.org/#dtstart=2009-07-22T20:35:28-07:00&lon=-122.270 &dtend=2009-07-29T20:35:28-07:00&zoom=14&types=AA,Mu,Ro,SA,DP,Na,Al,Pr,Th,VT, Va,Bu,Ar&lat=37.806&hours=0-2,4,6-8,10,11,13,15,16,18,19,21,22	Stamen Design
Job Voyager	http://flare.prefuse.org/launch/apps/job_voyager	Flare; UC Berkeley Visualization Lab
The Dumpster	http://artport.whitney.org/commissions/thedumpster/dumpster.shtml	
Presidential Watch '08	http://presidentialwatch08.com/index.php/map/	Linkfluence
British History Timeline	http://www.bbc.co.uk/history/interactive/timelines/british/index.shtml	BBC
Elastic Lists	http://well-formed-data.net/experiments/elastic_lists/	
Social Collider	http://socialcollider.net/	
US Demographics Visualizer	http://demo.idvsolutions.com/apps/censusdemo/flash/map.html	IDV Solutions
Buzztracker: World News, Mapped	http://buzztracker.org/	Craig Mod, Google
GapMinder	http://www.gapminder.org/	
Software Studies: Projects - Cultural Analytics	http://lab.softwarestudies.com/2008/09/projects.html	University of California San Diego Institute for Telecommunication and Information Technology
Nation on the Move	http://www.vectorsjournal.org/index.php?page=7&projectId=83	Vectors Journal - USC
Blooming Numbers	http://www.urielee.com/bloomingNumbers.html	Rochester Institute of Technology (Thesis Project)
History Flow	http://www.research.ibm.com/visual/projects/history_flow/index.htm	IBM
Human Flows	http://projects.flowingdata.com/humanflows/what.htm	Miguel Cabanzo
The Death Penalty Around the World	http://simplecomplexity.net/visualization/good-transparency-infographic-the-death-penalty-around-the-world/	Good Magazine
James Farmer Timeline	http://projects.umwhistory.org/farmer/timeline.html	University of Mary Washington
Global Food Archive	http://www.dartmouth.edu/~floods/Archives/GlobalFloods1985-2007.gif	Dartmouth Flood Observatory
Map of the Market	http://www.smartmoney.com/map-of-the-market/	Smart Money