



Cartographic Perspectives

*Journal of the
North American Cartographic
Information Society*

SPECIAL DIGITAL ISSUE 2

Number 66, Fall 2010



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IN THIS ISSUE

LETTER FROM THE GUEST EDITORS

<i>Tanya MA Buckingham and Robert E. Roth</i>	3
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FEATURED ARTICLES

Towards Geodesign: Repurposing Cartography and GIS? <i>Michael F. Goodchild</i>	7
---	---

On Waterlines: Arguments for their Employment, Advice on their Generation <i>Daniel P. Huffman</i>	23
--	----

The University of Wisconsin—Madison Arboretum Map <i>Timothy R. Wallace</i>	31
---	----

“They Would Not Take Me There” People, Places, and Stories from Champlain’s Travels in Canada 1603–1616 <i>Michael Hermann, Margaret Pearce</i>	41
---	----

George Washington’s American Atlas <i>Abraham Kaleo Parrish</i>	47
---	----

Running a Small Cartographic Business <i>Hans van der Maarel, Derek Tonn</i>	53
--	----

Programming Panning and Zooming in Interactive Maps <i>Andrew W. Woodruff</i>	59
---	----

Creating Mapping Applications for the iPhone <i>Kiichi Takeuchi, Patrick J. Kennelly</i>	71
--	----

Student Web-Mapping Competition 2009 <i>David Heyman</i>	85
--	----

NACIS Student Poster Competition 2009 <i>Patrick J. Kennelly</i>	88
--	----

Interview with a Celebrity Cartographer: Cindy Brewer <i>Robert E. Roth</i>	91
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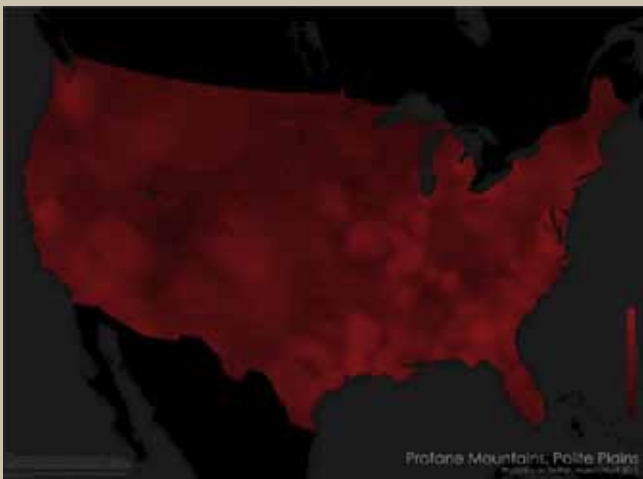
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WORDCLOUD ABSTRACTS

The wordclouds featured in the cover art and abstracts were produced using Wordle (<http://www.wordle.net/>). Complete text from each article was included.



Original image, http://www.nacis.org/CP/CP66/Huffman_Map.pdf (1.2MB)

ABOUT THE COVER

Isolines are based upon an interpolated surface generated from approximately 1.5 million geocoded public posts on Twitter between March 9th and April 12th, 2010. These data represent only a sample of all posts made during that period. Isolines are based upon the average number of profanities found in the 500 nearest data points, in order to compensate for low population areas. Prepared May/June 2010 by Daniel P. Huffman — daniel.p.huffman@gmail.com

Special thanks to Jeremy White for creating TwitterHitter to collect the initial data, and to Natural Earth* for the vectors.

*Since Natural Earth Data launched in December 2009 there have been 125,000 downloads and over 65,000 unique visitors from virtually every country in the world with nearly 500,000 total pageviews. The project is an ongoing collaboration involving many volunteers from around the world.

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LETTER FROM THE GUEST EDITORS

Members of the NACIS Mapping Family:

It is truly an exciting time to be a mapmaker. Today, we are afforded with an unprecedented volume of geographically referenced information, with estimates indicating that 80% of all newly assembled information have a geospatial signature. Similarly, we have witnessed an explosion of technologies developed to make use of this information, from desktop- or browser-based software that support and enhance the workflows of cartographers to mobile applications that have transformed the way in which everyday users engage with maps (and perhaps even how they engage with the world around them). It can be argued that there has never been more interest in mapping than now, with a variety of both formal and informal cartographic organizations, along with their associated meetings and publications, gaining significant traction worldwide.

This excitement is echoed by the current transitional phase of NACIS. As stewards of Cartography, NACIS has a responsibility to reach out to these nascent activities—to build connections across the increasingly fragmented cartographic community—in order to promote their messages and aid in their success. Further, we have a responsibility as a society to disseminate the collective body of cartographic knowledge accrued during NACIS's thirty years of existence for use by all mapmakers, regardless of their affiliation. NACIS remains committed to continued evaluation of the services offered to our membership to ensure we are fulfilling our mission.

It is in this context that we present the second of two special issues of *Cartographic Perspectives* distributed openly in digital form. The release of these two special issues comes at an important time in the history of *CP*, during which fundamental changes to its delivery and structuring are being explored in order to ensure that it remains an outlet for cutting-edge cartographic research and practice. The readership survey conducted by Amy Griffin and Fritz Kessler in 2009 identified several ways to improve *CP*'s content. The articles presented in the two special digital issues (#64 & #66) are illustrative of the new formats and styles recommended in the readership feedback. We plan to expand upon these experimental issues over the next year as we continue to explore new possibilities for *CP*.

The 2009-2010 NACIS Board was quick to identify the benefits to our membership, and to the field of Cartography, identified in the readership survey and enacted changes to *CP* in two stages. Stemming from the input from the readership survey, and the success of the first special digital issue, the switch to a digital medium was approved at the 2010 Spring Board Meeting held in Madison, WI. Advantages of a digital journal include expanded options for displaying our visual work (e.g., full color prints, no size/resolution constraints), the ability to access interactive maps and other web-based content, and a wider exposure of ideas generated within the NACIS community. The NACIS Board is mindful of the subset of members that still desire a printed version and will continue to offer a serialized, bounded version of each *CP* issue on-demand.

As the approval of digital *CP* generated more questions than answers, a committee was created at the Spring 2010 Board Meeting to define formally the transition mechanism to the digital medium. The Digital Transition Committee contained a mixture of academic and professional NACIS members to represent the diverse interests of NACIS and included Tanya Buckingham, Lou Cross, Gordon Kennedy, Pat Kennelly, Fritz Kessler, David Lambert, Margaret Pearce, Susan Peschel, Brandon Plewe, and Rob Roth. Committee members worked judiciously over the Summer of 2010 to define the vision for digital *CP* and presented their recommendations to the NACIS Board in August 2010. After discussion and revision, the recommendations were ratified unanimously prior to the 2010 Fall Board Meeting. Ratified decisions included continued provision of a print version of *CP* upon request (as described above), continued serialization into three issues, provision of an HTML web pre-print of articles upon acceptance (refereed articles can be made available online within 4-6 weeks of submission!), provision of moderated message boards for each article to facilitate two-way communication between the author and NACIS community, and creation of additional *CP* article formats that leverage the digital medium and respond to feedback from the readership survey. However, there is one fundamental change that requires special attention here: the exploration of a move to an open access model.

This year we hope you will join us as we lead the field in an experiment to convert our journal to an open access, online publication. A move to an open access journal carries with it many strategic advantages that will maintain *CP* as an outlet that encourages communication and coordination among cartographic thinkers. It is almost assured that the transition will increase readership, as anyone with an Internet connection can now access its contents. We expect the transition to increase the number and quality of contributions to the journal, as the wider circulation should result in greater opportunity for citation (for academic articles) and application (for practical articles); the ability to have peer-reviewed content publicly available within 4-6 weeks of submission is something that is not offered by competing Cartography journals, or really any other journal in Geography. Finally, and most importantly, a switch to open access is simply the right thing to do from an ethical standpoint, as David DiBiase so eloquently emphasized in his position paper leading the first special digital issue. The open access model is congruous to the mapgiving movement within NACIS (rather than data or designs, we are giving our knowledge) and provides an additional way in which we can build connections with and facilitate the success of other mapping communities. Thus, we view the transition to open access important not just for the continued health of *CP*, but for the mission of NACIS as a whole.

It is in the context of these fast-paced, but well thought-through, changes to *Cartographic Perspectives* that we introduce the second special digital issue. The articles presented in this special issue represent the integration of past *CP* traditions and emerging *CP* possibilities. The first two articles parallel *CP*'s transition from print to digital, as both describe topics with analog roots, but new digital opportunities. This special issue opens with a seminal introduction to GeoDesign by Michael Goodchild, a topic he states that has its origins in the use of transparent map overlays to support decision making some forty years ago, although one that is still lacking robust digital technologies today. Goodchild's article is followed by a piece from Daniel Huffman that revisits the waterlining technique, which includes digital design suggestions for the age-old cartographic depiction of coastlines.

The second pair of articles summarizes the unique design constraints and solutions for two cutting-edge cartographic projects, one digital and one print. Tim Wallace discusses the design and development of the recently launched *University of Wisconsin-Madison Arboretum Map*, an interactive, web-based application that leverages Web 2.0 technologies and volunteered geographic information to promote the Arboretum. This is followed by a discussion of work completed by Michael Hermann and Margaret Pearce to map Champlain's early travels through Canada, a print product that integrates European, Native, and *Cartographic Perspectives* to produce a rich narrative of his explorations. Together, this pair of articles illustrates the potential for continued innovation in both digital and print mapmaking, and thus the need for *CP* to continue to be an active outlet for both.

The third pair of articles is indicative of the diversity of NACIS, discussing topics identified as important by key subsets of members in the readership survey, but that perhaps have been underrepresented in past issues of *Cartographic Perspectives*. Contributing to scholarship in map librarianship, Abraham Kaleo Parrish provides an overview of the *George Washington's American Atlas* collection recently acquired by the Yale Map Department, a set of 43 map sheets formerly in the possession of Washington himself; as with future issues of *CP*, the contents of this atlas are being made freely available in digital format for public consumption. This article is followed by a piece from Hans van der Maarel and Derek Tonn offering practical advice to fledgling freelance cartographers, covering topics such as business organization/legalities, product pricing, balancing freelance work with other activities, business focus, and collaboration with other freelancers.

The fourth pair of articles presents an example of the new *On the Horizon* section recommended by the Digital Transition Committee to leverage the digital medium. This new section provides introductory and advanced tutorials on emerging topics in dynamic & web-based mapping and is a complement to the traditional *CP* tutorials included in the *Practical Cartographer's Corner*. Andy Woodruff presents an introduction to map browsing, providing a code library and tutorial for implementing multiple forms of panning and zooming in interactive, web-based maps using the Adobe Flash development environment. Following this piece, Kiichi Takeuchi and Patrick Kennelly present a tutorial for generating a mobile mapping application using GeoGears, a customizable application developed by the authors that simplifies development of iPhone mapping applications; GeoGears is openly available for use and extension, again mirroring the transition of *CP* to open access.

The final articles present examples of the new *In the Marginalia* section recommended by the Digital Transition Committee to make portions of *CP* more magazine-like, a common comment in the readership survey. This section will include a cycle of three articles, each printed once a year: an update on the status of NACIS from the newly created Communication Director position, a highlight of the annual Student Web Map and Poster Competition winners, and an interview with a long-time NACIS member, using the same set of ten questions each year; examples of the latter two are provided in this special issue. Summaries of the 2009 Student Web Map and Poster Competition are provided by David Heyman and Patrick Kennelly, showcasing the award winning maps. Importantly, Patrick Kennelly also announces the creation of a third student competition: the *Cartographic Perspectives* Student Peer-Reviewed Paper Competition (with a purse of \$1350!). The final article included in the special issue is an informal interview with Dr. Cindy Brewer, one of NACIS's longest tenured members and one of *CP*'s most prolific contributors. In the interview, we get to hear about Cindy's origins as a cartographer (scans of pen-and-ink maps from her undergraduate classes are included!), some fun stories about her experiences with NACIS and NACIS members, and her outlook for the future of Cartography.

We close by emphasizing the fundamental role of *CP* to the vitality of NACIS. *CP* affords the opportunity to extend and formalize the conversations initiated at the NACIS Annual Meeting, allowing us to continue to teach each other how best to make and use maps. It is an important record of our evolution as a society, archiving the focal topics and perspectives of our past and suggesting alternative possibilities for our future. It is an important way that we build connections with other cartographic communities that are not yet formal members of the NACIS community. Most importantly, *CP* is, and should always be, a reflection of the interests, abilities, and concerns of the NACIS membership. *Cartographic Perspectives* is yours, and we hope equally that its pages always contain material in which you are interested and that you always feel welcomed as a contributor. Your unique cartographic perspective deserves to be heard!

We appreciate the feedback on *CP* you have provided that ultimately led to the aforementioned changes, we thank the authors of this special issue for their excellent contributions, and we encourage continued suggestions to make *CP* a true reflection of breadth within Cartography.

Tanya MA Buckingham
and Robert E. Roth

factors important in the decision. The net effect of each of the factors would be represented by the amount of light penetrating the layers at each point, allowing the decision maker to make an intuitive judgment as to the best solution. This is one of the central ideas of McHarg's (1969) *Design with Nature*, and the stack of layers has become an icon of the entire field of GIS, appearing on the front covers of many of its textbooks. One of the strongest arguments for GIS has been its ability to place such a simple and intuitive concept as overlaying transparent maps on a solid, reproducible—one might go so far as to say *objective* and *scientific*—footing. Abundant examples of this idea can be found in the field's textbooks, ranging from site selection for industrial plants to routing of power lines or highway corridors.

However, in the four decades that have elapsed since its birth, this notion of GIS as improving the process of design has become less central. GIS has evolved into a tool for performing spatial analysis in support of scientific discovery, a system for managing inventories of spatially distributed assets, a platform for automating the cartographic process and displaying information in map form, and a medium for communicating what is known about the surface and near-surface of the planet (Sui and Goodchild 2001). Yet we increasingly are aware of the planet's fragility, and of the need to make wise decisions about its future that are informed by evidence and by the best scientific knowledge. Now, more than ever, we need a technology of design that can work in tandem with human decision-making processes, bringing what we know about how the planet works to bear on the decisions that have to be made about its future. Humans have the power both to destroy the planet and to sustain it. We need tools that can predict for us the effects of tinkering with the Earth system, thus helping us to be effective stewards of the only planet we have.

This concept of science-based design sits at the interface among several disciplines. It involves the disciplines that traditionally have concerned themselves with design, including planning and landscape architecture. But it also involves the disciplines that acquire and accumulate fundamental knowledge about how environmental and social systems operate, including geography, ecology, hydrology, earth science, sociology, economics, and political science. Finally, it includes the new disciplines of information technology, especially geographic information science (GIScience; Goodchild 1992). Input from all three of these sets is needed if decisions are to be supported by well-designed and powerful tools that are easy to use, and by the results of good science.

Over the past decade, there have been several discussions of the need to close what many have perceived as the growing gap between GIS and design. In January 2001, a workshop was held in Santa Barbara, California on Landscape Change, organized by a joint committee of landscape architects and GIScientists (<http://www.ncgia.ucsb.edu/landscape/landscape.htm>). A second workshop on Spatial Concepts in GIS and Design was held in Santa Barbara in late 2008 (<http://www.ncgia.ucsb.edu/projects/scdg/>). The term *geodesign* was suggested as a useful umbrella term for this examination of the common ground between GIS and design, with its implied emphasis on the

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geographic domain and geographic scales. Most recently, in January 2010 the first GeoDesign Summit was convened in Redlands, California (<http://www.geodesignsummit.com>), bringing together GIS and design practitioners from academia, non-governmental organizations, government agencies, and the private sector, with over 150 participants from across a wide range of disciplines.

This paper presents one person's view of the nature of geodesign, of its objectives, of how the field might be conceptually framed, of its relationships to existing fields (especially cartography and GIS), and of research issues that need to be addressed if current impediments to effective geodesign are to be removed. The remainder of the paper is organized as follows. The second section reviews alternative definitions of geodesign, its domain of application, and its cognate disciplines. The third section discusses the McHarg vision and its limitations, updates it to the present day, and presents a brief critique. The fourth section describes the tools and computing environment that would be needed to support a fully-fledged practice of geodesign. The final section ends with some suggestions for future developments. The discussion is inevitably personal, with no implication that all possible topics and arguments have been covered. Nevertheless, the paper may provide a useful increment in our understanding of the nature of geodesign and of what needs to be done to move its agenda forward.

WHAT IS GEODESIGN?

DEFINITIONS

The GeoDesign Summit website quotes Carl Steinitz: "Geodesign is geography by design," a compellingly simple definition. If geography is the set of processes that operate on or near the Earth's surface, together with the forms that result from such processes, then geodesign is concerned with manipulating those forms and intervening in these processes to achieve specific objectives. Thus, it is *normative* in the sense that decisions are made about aspects of the geographic domain in order to achieve specified objectives, or *norms*. Normative efforts stand in contrast to the traditional aim of science, to discover general truths about the world; geodesign is *interventionist* in contrast to the more detached and dispassionate nature of pure science. Geodesign seeks to improve the world, whereas traditional science seeks only to provide the basis of knowledge on which the world might eventually be improved. Pure science is often carefully partitioned from application, and often sees its responsibilities as discharged when results have appeared in the pages of refereed journals. In that sense, geodesign lies within the domain of applied science and engineering, seeking ways of addressing practical problems using the scientific method.

Wikipedia defines geodesign as "a set of techniques and enabling technologies for planning built and natural environments in an integrated process, including project conceptualization, analysis, design specification,

stakeholder participation and collaboration, design creation, simulation, and evaluation (among other stages).”The emphasis here is on built and natural environments, or Steinitz’s geography, and also on the integration of the entire design process, presumably through technology.

Both of these definitions imply a very broad and traditional interpretation of the planning process. Others, however, have focused more on how planning can take advantage of the capabilities of GIS. Wikipedia also quotes Flaxman’s address at the GeoDesign Summit: “Geodesign is a design and planning method which tightly couples the creation of design proposals with impact simulations informed by geographic contexts.” In other words, the ability of modern GIS to create highly compute-intensive simulations of the effects of design scenarios provides an additional dimension to the traditional planning process, with its emphasis on visual display and intuition: geodesign is planning informed by scientific knowledge of how the world works, expressed in GIS-based simulations. In a similar, though less compute-intensive vein, and quoting Jack Dangermond from the GeoDesign Summit website, “Imagine if your initial design concept, scribbled on the back of a cocktail napkin, has the full power of GIS behind it. The sketch goes into the database, becoming a layer that can be compared to all the other layers in the database.” Clearly, comparison of layers is only one of the multitude of functions that are easily invoked with today’s GIS. Nevertheless, *sketch* and *simulation* provide two distinct notions of how the computational environment of a GIS might support geodesign.

One might also compare geodesign with other more widely recognized and traditional terms, such as computer-aided design (CAD). GIS has often been distinguished from CAD (Cowen 1988) by its emphasis on a geographic reference system, the richness of the attributes associated with features, its ability to deal with continuous fields (Couclelis 1992) in addition to discrete objects, and its rich set of analytic and modeling functions. In essence, the emphasis in CAD is on designing a structure through digital representation; in GIS it is on analyzing and modeling the structures present in the social and environmental worlds; and in geodesign it is on user-driven intervention in those worlds.

SPATIAL OPTIMIZATION

There is a long tradition of finding optimal solutions to design problems in the research domain known as spatial optimization. Much of this literature concerns finding optimal locations for point-like facilities, such as schools, fire stations, retail stores, or restaurants (Ghosh and Rushton 1987). Numerous problems have been formulated, depending on the exact nature of the application, the objectives and constraints that apply, and the nature of the space within which optima are sought. For example, the field of location-allocation concerns the search for one or more locations for point-like facilities to serve a dispersed demand, and solutions involve both the optimal locations of the facilities and the service areas that each will cover.

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More generally, spatial optimization problems can be characterized by the type of information represented by the solution. Some problems seek optimal locations for points, some for lines (e.g., transmission corridors), and some for areas (e.g., optimal allocation of land for specified uses). Some problems seek optimal allocations of one set of features to another, as in the case of optimal allocation of service areas for schools, or optimal patterns of transportation from origins to destinations. In general, a spatial optimization problem might find solutions in the form of any augmentation of a GIS database. From an object-oriented perspective (e.g., Zeiler 1999), this might mean the creation of a new feature class; the addition or deletion of features from an existing class; the addition or modification of one or more attributes of a feature class; the creation of a new association class representing patterns of interaction between existing origins and destinations; the creation of new routes that are themselves aggregations of an existing edge feature class, etc. In this way, the problems formulated as spatial optimizations can be related directly to the elements of a modern GIS database design. More broadly, we can see geodesign as transforming an existing database **D** into a new one **D'** through some combination of edits.

Spatial optimization provides a useful framework for geodesign, although it is often far too simplistic, as the next section explains. Spatial optimization requires an *objective function* that reflects the goals of the design, expressed in numeric form as a function of the solution variables that are available to be manipulated by the designer. It requires a *solution space* that is defined by the *solution variables* and limited by the *constraints*. The final design will occupy one point in the solution space. In geodesign, the solution variables all can be found in the database, as attributes or geometries of features, or as attributes of association classes. The user is able to interact with the solution variables in various ways, such as by using sketch tools to define or edit their geometries, or using the keyboard to define or edit their attributes.

THE USER IS ABLE TO INTERACT WITH THE SOLUTION VARIABLES IN VARIOUS WAYS, SUCH AS BY USING SKETCH TOOLS TO DEFINE OR EDIT THEIR GEOMETRIES, OR USING THE KEYBOARD TO DEFINE OR EDIT THEIR ATTRIBUTES

BIG-D AND SMALL-D DESIGN

Spatial optimization often is seen as a task to be performed by a machine with no human intervention—as a fully automated edit of a database. Once the objectives and constraints are formulated, and the data are assembled, the machine is allowed to take over, producing a solution that by definition represents the best possible decision. It is often argued that such formal procedures provide a vast improvement over the messy, intuitive process of more traditional decision making. Disagreements between stakeholders over the objectives and constraints, or over the weights to be applied to different factors, can be handled through a variety of equally rigorous and mechanical *multi-criteria* problem formulations (Thill 1999). However, courts have sometimes held that a solution can be unacceptable against certain criteria, such as racial bias, even though the objective function and constraints included no such bias. Moreover, it may simply be naïve to believe that human rationality, in the form of rigorously formulated optimization problems, can ever replace the messy nature of politics. Instead, spatial optimization is better seen as a collaboration between human and machine,

in which the machine's role is simply to perform the calculations and iterations that humans find tedious—with the human still firmly in control. This argument provides a useful basis for distinguishing between two visions of the design process. Small-d design takes a simplified view—design consists of the formulation of an optimization problem with objectives and constraints, the collection of data, the execution of a search for the optimum solution, and its implementation. In this somewhat naïve and simplistic view, implementation is seen as inevitable, because all participants agreed on the objectives and must therefore accept the result. Small-d design most commonly is associated with the disciplines of operations research, engineering, and management science.

Big-D Design sees the process as complicated by disagreements among stakeholders, difficulties in deciding what is optimal, feedback loops that modify objectives, constraints, and data as the process proceeds, and uncertainties about implementation. Figure 1, taken from the work of Steinitz (1990; Steinitz *et al.* 2003), structures Design as a sequence of six

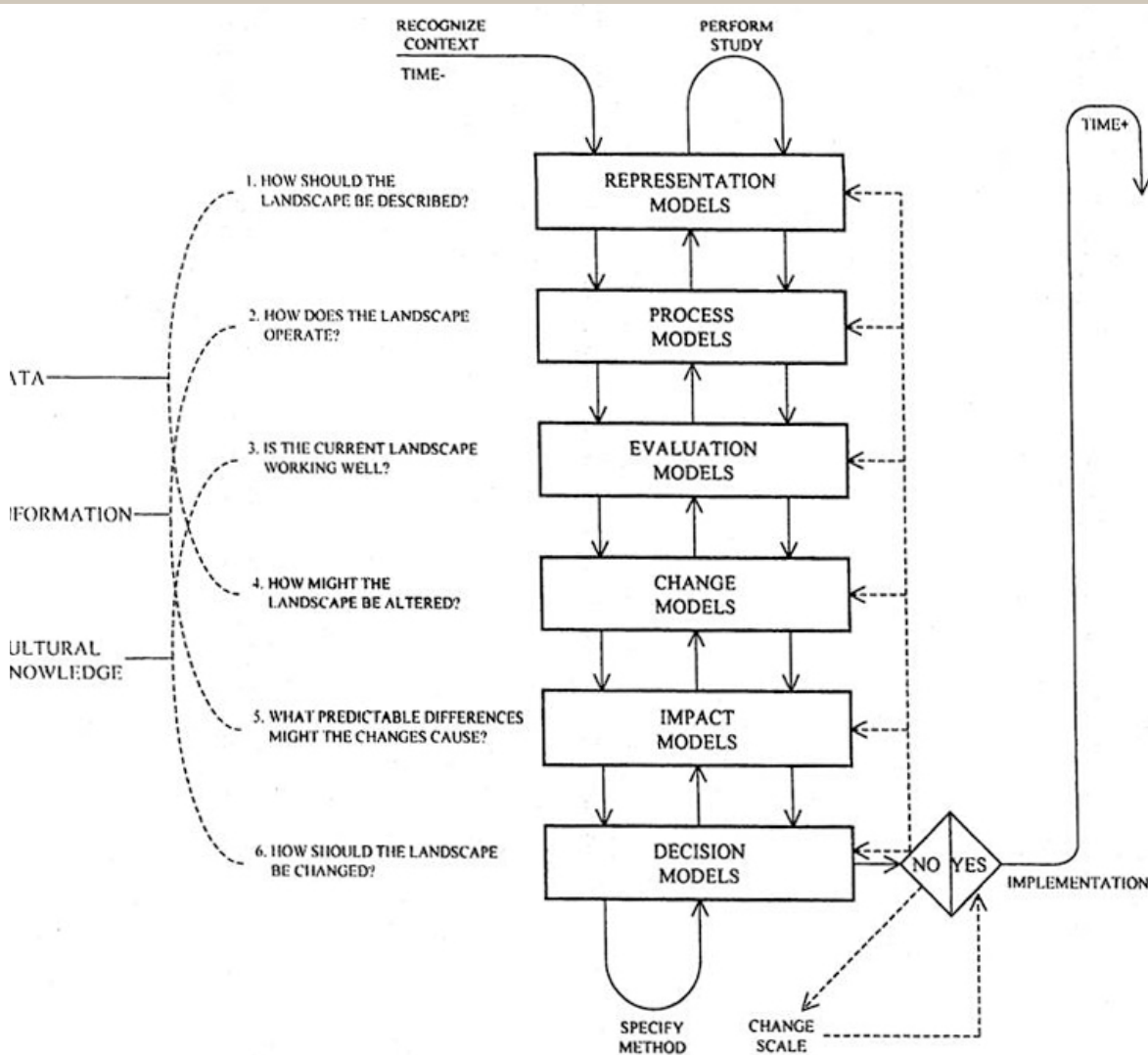


Figure 1. A six-stage framework for the Design process, with models at each stage (Courtesy of Carl Steinitz).

stages with iterative feedbacks—and similar schemata can be found in other sources. Each of these stages might be formalized as a model and supported by computational tools. Big-D Design most commonly is associated with the disciplines of landscape architecture and planning. As the dominant paradigm of geodesign, big-D Design—rather than small-d design—will be implied whenever the term design is used in the remainder of this paper.

The problem of conservation planning provides a useful illustration of the difference between design and Design. Conservation planning seeks to acquire a set of conservation areas in order to best preserve one or more biological species. A set of models is constructed from empirical data to predict the ability of a given parcel of land to support a given species. A spatial optimization problem is then formulated, seeking the best combination of land acquisitions to provide a sustainable population of the target species (Hof and Bevers 2002). Issues such as the connectedness of parcels are important to allow for interactions between breeding populations. The results can be expressed in the form of a new attribute of the land-parcel feature class, denoting whether or not each land parcel is targeted for acquisition. Thorne, Cameron, and Quinn (2006) provide an example plan for land acquisitions in Southern California to preserve the mountain lion.

However, it is naïve to believe that the publication of such a plan will have no impact on the market for land, or on the attitudes of landowners. Instead, it commonly creates a strong and sustained reaction among the potentially affected landowners. Moreover, parcels inevitably will be acquired over an extended period of time, and it is likely that some of the optimal set will prove impossible to acquire, and will be replaced by alternative near-optimal parcels. In principle, each replacement affects the optimality of the entire solution, so the problem needs to be re-solved after every acquisition. In reality, then, the simple spatial optimization problem (design) is embedded in a much more complex process (Design) that is characterized by large amounts of uncertainty. Gallo (2007) shows how important it can be to avoid publishing a single, deterministic optimum solution, and instead suggests focusing on relative priorities expressed in probabilistic terms.

THE DISPLAY OF
GEOGRAPHIC
INFORMATION IN
MAP FORM IS OFTEN
SEEN AS AN
INDISPENSABLE PART
OF ANY GEODESIGN
PROCESS

GEODESIGN AND CARTOGRAPHY

The display of geographic information in map form often is seen as an indispensable part of any geodesign process. Geodesign is by definition about geographic space, and Dangermond's definition quoted earlier points directly to cartography and the role of the computer as transforming an informal sketch into an element of a formal database. One of the achievements of GIS over the past 45 years has been the development of an integrated theory of geographic data representation, in other words, of a formal model of phenomena distributed over the surface and near-surface of the Earth. It includes discrete objects and continuous fields; points, lines, areas, and volumes; approaches to the representation of time; and solutions to the problem of representing flows and interactions (Goodchild, Yuan, and Cova 2007). GIS has progressed substantially beyond the earlier *map*

metaphor, when a GIS was viewed informally as a computer containing maps (Goodchild 1988). Animation, for example, is now almost routine in computerized displays, but was impossible as long as maps were confined to analog form on paper.

A two-dimensional display of geographic data, with the defining dimensions of the display representing (*mapping* in its mathematical sense) the spatial dimensions of the data, is a powerful way of showing the user what is present at every location within the extent of the display. Every point on a paper map can be printed with any color, and similarly every pixel on a computer display can be programmed to display any color. The visual impression of linear features is created by using a similar color along a linear sequence of points or pixels, and similarly an area is visualized by displaying its boundary, or by filling it with a uniform color or pattern. Annotation is communicated by linking points or pixels into the form of characters.

Nevertheless, it has always been difficult to use this approach to display geographic information that concerns points taken two at a time—in other words, relationships or interactions between mapped features (Takeyama and Couclelis 1997). It is difficult, for example, to label a feature on a map according to the several names given to it by the inhabitants of neighboring areas, or to show flows of migrants or telephone calls. Such flows occur between pairs of features (origins and destinations), are not independent properties of either, and therefore cannot be displayed by symbolizing either feature alone, or even in combination. Lines might be drawn to connect origins and destinations, and appropriately symbolized, but in many cases the actual path of flow is not known (Glennon 2010), and a large number of such lines can render the map unreadable. In the previous section, this type of information was characterized as an association class in the object-oriented paradigm. In short, while the results of any spatial optimization can be regarded as a modification of a database, not all such modifications are equally easily visualized cartographically. Sketch is an important way of communicating simple geographic features between user and GIS, and other important kinds of input can also be captured through interaction between the user and a map display. More broadly, cartography is a useful part of geodesign, but not all aspects of geodesign are inherently cartographic.

CARTOGRAPHY IS
A USEFUL PART OF
GEODESIGN, BUT
NOT ALL ASPECTS
OF GEODESIGN
ARE INHERENTLY
CARTOGRAPHIC

THE McHARG VISION

Reference has already been made to the early days of GIS and the importance of design based on multiple layers of input. McHarg's vision for his school of landscape architecture at the University of Pennsylvania used the stack of layers as a metaphor for the organization of the school (McHarg 1996). Each layer corresponded to one discipline whose subject matter was important to landscape design, including ecology, hydrology, and geology. Overlaying the layers symbolized the simultaneous attention that needed to be paid to each of these as a plan was developed. Each layer would be shaded according to the weight to be assigned to the corresponding discipline's

issues, and the relevant factors present at each point.

This is only one aspect of McHarg's contribution, of course, but it is emphasized here because of the way it links design and GIS, and thus relates to the topic of this paper. Suppose, for example, that the impact of a proposed pipeline at location \mathbf{x} is determined to be $z_e(\mathbf{x})$ per unit area, when measured from the perspective of ecology. Similarly, the impact of the pipeline at \mathbf{x} from the perspective of hydrology might be $z_h(\mathbf{x})$ per unit area, and the economic cost of acquiring the necessary land might be $z_c(\mathbf{x})$. The three measures are incommensurate, of course, so weights must be assigned to reduce them to a common metric, and to rate their relative importance. Define these weights as w_e , w_h , and w_c respectively. Then the problem can be formulated as finding a route such that the total weighted cost along the route is minimized. If S denotes the solution set, that is, the set of points along the route, then the task is to minimize:

$$Z = \sum_{\mathbf{x} \in S} [w_e z_e(\mathbf{x}) + w_h z_h(\mathbf{x}) + w_c z_c(\mathbf{x})]$$

In the analog method described in *Design with Nature* (McHarg 1969), both w and z must be captured by the darkness of the corresponding layer at point \mathbf{x} , and the optical process of overlaying layers replaces the summation in the equation by a multiplication. In reality, of course, the kind of rigor exhibited in the equation was never intended to be imposed in the analog method, but the more formal GIS overlay process forces the user to address all of these issues explicitly. For example, the weights w might be assigned using Saaty's Analytical Hierarchy Process (AHP), or a variety of other methods that are described in the standard texts on multicriteria decision analysis (Malczewski and Rinner 2010; Thill 1999). Similarly, it is common to address the "apples-and-oranges" issue of non-commensurate variables by normalizing each to the range 0 to 1. But since the observed range depends on the exact extent of the study area, there are obvious logical flaws in this practice.

Despite the informality of the analog model, McHarg clearly intended his design process to be informed by science, and achieved this by constructing each layer according to the knowledge base of the corresponding discipline. Moreover, the school included representatives of each of those disciplines on its staff, forcing intensive engagement and interaction. This is a very different approach from that commonly followed in most universities, where the science disciplines are separated from the design disciplines, often across the boundaries between colleges or faculties. One of the underlying themes of geodesign is its potential to reduce that separation.

McHarg's vision is now more than four decades old, so it makes sense to ask whether and how it should be updated to the present. Enormous advances have been made in the disciplines that study social and environmental processes on the Earth's surface, and an argument can clearly be made for including all of them to the extent that they are relevant to a specific design question. But in addition, we know far more now than we did then about the

process of decision making, and particularly about the role of uncertainty. Thus, it would seem important to include decision scientists and statisticians in the mix, especially spatial statisticians. We also would need to include the computer scientists and information scientists who address issues of representation and develop the algorithms needed to implement scientific knowledge—especially geographic information scientists—and the experts in remote sensing and sensor networks who address issues of spatial data acquisition. We also would need to include the cartographers and specialists in spatial cognition who address human factors in the interactions between designers and tools, and the social psychologists who study processes of group interaction.

COMPUTATIONAL SUPPORT FOR GEODESIGN

In the complex process represented by Figure 1, geodesign can be partitioned into a series of stages, each underlain by a model and each supported by computational tools. This is very different from the conceptualization of small-d design, in which the entire process occurs in a single stage, and in which a large proportion of control is surrendered to the computational system and its task of finding the best solution. The field of *spatial decision support systems* (SDSS) has long addressed the kinds of computational tools needed to support design decisions, and has accumulated a substantial literature (Leung 1997; Sugumaran and Degroote 2010). Li and her collaborators have recently constructed a very substantial collection of Web resources (<http://www.institute.redlands.edu/sds>), including an ontology of SDSS, in an effort to address the varying use of terms and to clarify the field's relationship with other cognate fields.

What then is the relationship between SDSS and geodesign? SDSS has its roots in the early 1990s (Densham and Goodchild 1990), and in a desire to apply GIS tools to a host of problems of spatial optimization. SDSS has always had a strong science base, so one might see geodesign as an effort to expand SDSS to include some of the design problems that have traditionally made less use of scientific knowledge to simulate the effects and impacts of plans. In other words, traditional SDSS may best be seen as a subset of geodesign, if any distinction is needed.

Reference was made earlier to the notion that there are two areas where geodesign tools need further development:

SKETCH TOOLS

The first key area of support for geodesign is *sketch*, or the ability of the user to create informal renderings of points, lines, and areas in geographic space, and to have the computational system capture, formalize, and store these. ESRI's ArcSketch already offers some of these capabilities, and Google's

SketchUp extends them to the third spatial dimension.

In essence, sketch tools would allow the user to edit a GIS database by inserting new point, line, and area features. These might be added to existing feature classes or might be captured as entirely new classes. For example, a user seeking the best locations for a number of new retail stores to add to an existing chain might sketch potential locations. The system then might evaluate these locations based on a predictive model of store sales, or use them as the starting points for an optimal search procedure. From this perspective, sketch tools are augmentations of existing GIS database editing functions. But the emphasis is rather different; in conventional editing, the user seeks to approximate a *truth*, as expressed perhaps by a source document, whereas no such truth exists in the case of sketch, which is inherently vague.

IN CONVENTIONAL EDITING, THE USER SEEKS TO APPROXIMATE A TRUTH, AS EXPRESSED PERHAPS BY A SOURCE DOCUMENT, WHEREAS NO SUCH TRUTH EXISTS IN THE CASE OF SKETCH, WHICH IS INHERENTLY VAGUE

SIMULATION TOOLS

The second area is *simulation*, or the examination of design scenarios by simulating their impacts based on sound scientific knowledge. For example, the impacts of a proposed new highway might be examined by simulating its effects on the pattern of traffic in the surrounding area; on the downstream effects on local hydrology; and on noise and atmospheric pollution. Calibrated models exist for each of these sets of impacts as a result of basic scientific research. Moreover, in many areas large numbers of models exist, based on different sets of assumptions, requiring different inputs, and yielding different answers. One of the most valuable outputs of a GIS simulation may lie in the uncertainties associated with predictions, based on uncertainties within each model and on variation across models.

Many successful efforts have been made to integrate models of social and environmental processes into GIS, and the results are described in a substantial literature (Goodchild, Parks, and Steyaert 1993; Skidmore 2002). Many models are difficult to integrate with GIS and with other models because of lack of standards governing data formats, and there is also a need for greater standardization in the languages in which model software is written. Both of these factors impede the goals of geodesign, because they make it difficult to implement many models as simple functions of a geodesign software environment.

More specifically, research is needed to address two issues of major importance:

1. Models need to be encapsulated easily within GIS, so that they can be executed and the results analyzed within the workflow of a geodesign process. This implies that data inputs and outputs need to follow GIS data format standards so they can be integrated readily with GIS databases, and that model parameters be exposed to the user through a GIS interface.
2. Models need to be written in a common language, so that their component parts can be reassembled and reused readily. In practice,

models are commonly written in a range of computing environments, from source languages such as C++ to scripting languages such as Python. Efforts to develop a common, uniform language for GIS have made only limited progress in the past (e.g., the Map Algebra of Tomlin 1990), though van Deursen's scripting language for PCRaster (van Deursen 1995) offers a comprehensive solution at least for simulations over a cellular landscape. A comprehensive solution to this problem would be a major contribution to the goals of geodesign.

Behind this need for a common language lies a much more fundamental problem, that of defining a standard set of GIS operations. While various taxonomies have been published, it is regrettably true that after 45 years of GIS development there exists no standard set that is defined on a rigorous conceptual basis. Instead, the sets of functions offered by popular GIS packages, such as the ArcToolbox, are the result of a haphazard historical process of development. There are no universal standards and no rigorous concept of granularity, making it difficult to discover functions offered on the Web and undermining the entire concept of service-oriented architecture. A conceptual framework for the structuring of GIS functionality would be an enormously valuable contribution, enabling a new level of interoperability across the GIS field.

DISCUSSION AND CONCLUSION

It will be obvious from the preceding sections that geodesign is not new, but instead represents a re-examination and perhaps a repurposing of a number of established fields. In the case of GIS, this re-examination is prompted by a perceived lack of attention to the use of GIS in design, and to its potential role in improving the geographic world. In the case of spatial optimization, it is prompted by the perception that design problems are more complex than simple mathematical formulations, and that the political process of decision making is more complex than the execution of a single optimization. In the case of landscape architecture, it is prompted by the notion that science can play a much stronger role in informing important decisions over the use of land, and that GIS is a valuable platform for integrating scientific knowledge into the design process.

The design of tools is driven by a constant tension between the specific and the general: between the scale economies that result from a one-size-fits-all solution, and the speed with which a targeted solution to a specific problem can be constructed. In the 1970s, GIS emerged as a generic solution to a set of requirements that ranged from cartographic editing to land-use planning and the administration of the census. Today, a suite of integrated geodesign tools may emerge from the realization that a host of geographic design problems share a common structure, and rely on access to a common GIS database. Just as with GIS, the attendant economies of scale in software

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production, training, and documentation would be enormous.

For that to happen, however, several issues have to be resolved. Two have already been mentioned: the lack of interoperability between existing model codes, and the lack of a language within which an integrated vision of reusable codes could be implemented. In addition, however, it is important to address the question of how a suitable computing environment, once defined, might be widely adopted. Several successful models can be found in the history of GIS:

NOW MORE THAN
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THE FOUNDATION FOR
SUCH TOOLS

1. *The commercial software route.* Commercial software developers have the development staffs and the necessary mechanisms for promotion, training, and support to turn a design into a widely adopted reality. An advisory group of geodesigners might define the framework, and ensure that it was successfully implemented in tools.
2. *The open-source route.* GRASS was an early and highly successful effort to develop a comprehensive GIS for environmental modeling, based on open-source code and a network of researchers who added routines within a loosely defined set of standards. The role of the US Army Corps of Engineers in providing the initial foundation was critical, and suggests that a suitable strategy would be to obtain a major grant from a funding agency to construct the framework and to build the initial community of contributors and users.
3. *The research center route.* GeoDa (<http://geodacenter.asu.edu>) is another example of a highly successful package of tools, in this case addressing the needs of social scientists for easy-to-use software for spatial analysis. It was developed under a major center grant from the US National Science Foundation, which funded not only the code but also tutorials and workshops that publicized its applications.

Design was clearly an early objective of GIS, but as argued earlier, it tended to lose its centrality as GIS evolved to serve more lucrative and immediate markets. Now more than ever, we sense the need for effective tools that can help us to ensure a desirable future for the planet, and GIS clearly contains the foundation for such tools. The concept of geodesign presents a simple banner for a renewed effort to emphasize the value of cartography and GIS as tools for improving and sustaining the surface and near-surface of the Earth.

ACKNOWLEDGEMENT

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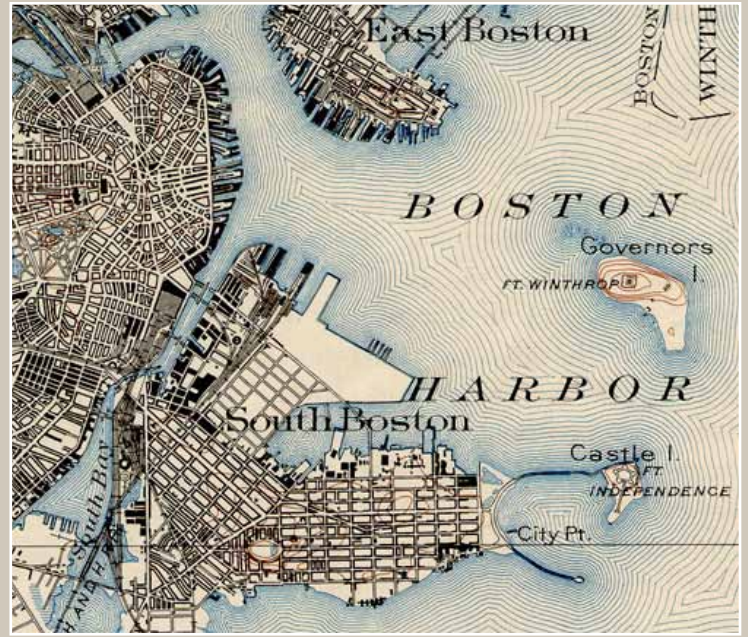


Figure 1. Two historical examples of waterlining. Left: Coast of California, from the "Geological and Topographical Atlas Accompanying the Report of the Geological Exploration of the Fortieth Parallel," 1876. Right: Boston Harbor, 1903 USGS topographic map.

in the existing literature as to why they were considered so useful as to be worthy of such funding. Certainly the cartographers of that era had reasons for spending great sums of money on waterlines, and if they were a critical budget item in the nineteenth century, I believe they must be able to provide something to the modern cartographer as well. While this article will finish up with a discussion of *how* to create them in the twenty-first century, we must first make an attempt to answer the question of *why*, which is long overdue.

THE BENEFITS OF WATERLINES

Waterlines offer an excellent way to establish figure-ground. The distinction between water and land in Figure 2 is quite plain, and yet it consists in only a few grey lines. The land and water polygons themselves are both filled white, though the waterlines can create an optical illusion that makes the water *appear* to be filled in with a darker color than the land. The subtlety and elegance with which they can divide land from sea is perhaps their greatest advantage. The series of fine lines is not very dominant, allowing the base map to settle into the background of the visual hierarchy potentially more easily than if the entire water area were filled in with a solid color. Keeping the land and water the same color also helps free up a fill color for use elsewhere on the map. In grayscale or other constrained-palette work, this can be a significant advantage.

Waterlines make water look more like it should. Water in the real world moves with the wind, whereas your average cyan lake polygon on a map just sits there, uncannily immune to nature. Waterlines are evocative of waves washing up on the shore, and adding them to a map restores a bit of the dynamism that



Figure 2. A modern example of digital waterlining

a reader would expect to see if they were out observing an actual lake¹. This makes water features easier to interpret by giving the reader a sense of realistic motion, letting them look through the map and perceive, in their mind's eye, a moving, living lake. We also can place this argument in more technical, semiotic terms—and here I draw heavily upon MacEachren's (1995) excellent overview of the sometimes-daunting subject. Adding waterlines reduces the degree of arbitrariness of waterbody symbols, meaning simply that the symbols now look more like their real world referents. The closer our sign-vehicle (the image we've drawn of a lake on our map) visually becomes the referent (the actual lake out in the world), the more easily a map reader can make the connection and come up with the desired interpretant (the mental concept of a lake).

But using waterlines as sign-vehicles does more than simply improve our ability to plant the idea of "lake" in our readers' heads; waterlines invoke other interpretants—generate other mental images—as well. The connotations they carry will vary from reader to reader, but three common ones come to mind: art and beauty, motion, and history.

Let's start with art. Waterlines can be seen as embellishments or decorations, as not strictly necessary. Their addition reminds the reader, on some mental level, of the human need to create art beyond the simple functional transmission of information. They can make a map feel more like it came from a feeling, sensate author, rather than a computer algorithm with no sense of beauty.

As addressed above, waterlines help designate bodies of water by giving them the appearance of waves. This means they also connote the abstract concept of motion. It is not just water, it is *moving* water, and the whole map now becomes subtly animated. There is a downside to this, however. The mental image of a wave-filled lake would be misleading if, for example, the real world lake in question was generally quite placid.

Finally, waterlines connote a sense of history. Waterlining appears largely in eighteenth and nineteenth century Western cartography, and any modern usage can generate, in the reader's mind, a mental connection with this historical body of work. Beyond that, they can bring to mind the various concepts that the connotation of historicalness can itself connote: authority, reverence, tradition, etc. Making use of this set of interpretants necessarily requires that waterlines not be part of current convention, and therefore helps perpetuate their rarity. I would argue that this is problematic, in that it prevents waterlines from becoming a regular part of the modern cartographer's design kit. Nonetheless, it is certainly a legitimate and powerful reason for employing them.

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¹Because of this sense of moving water, I originally called them wavelines, before learning that waterlines is preferred. I still prefer the vividness of the former term, though I am willing to capitulate to tradition.

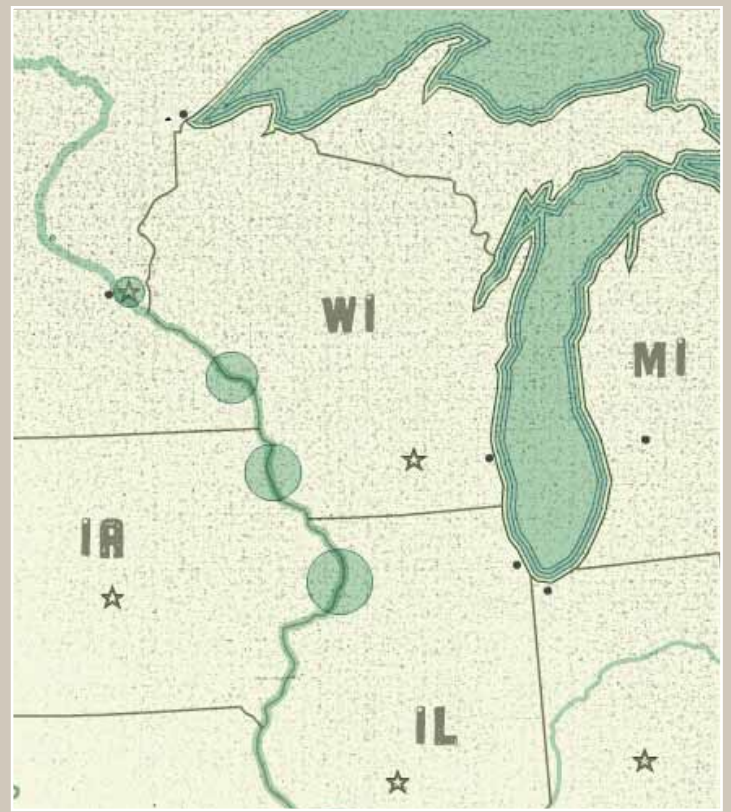
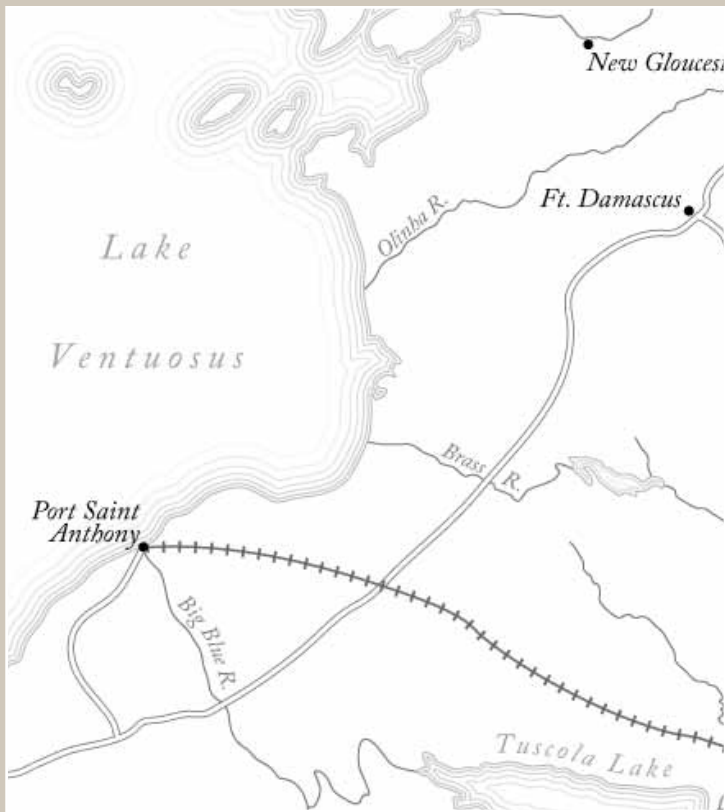


Figure 3. Two modern examples of waterlining. The map on the left is patterned after Victorian styles, while the one on the right, provided by colleague Tim Wallace, uses waterlines as part of a neo-historical, pop art letterpress aesthetic.

GENERATING WATERLINES

Creating waterlines is a relatively simple process. Most GIS packages contain a tool to calculate buffers around polygons; buffers are simply new polygons whose outer edges are a set, constant distance away from the original polygon, following its contours. This is exactly what a waterline is—a line which keeps a constant spacing from the shore, running parallel to it. Repeated applications of a buffer tool (or the Offset Path tool in Adobe Illustrator, which functions much like a GIS buffer tool), then, is all that is needed to generate a series of waterlines. Buckley and Barnes (2005a and 2005b) and Buckley (2009) have detailed how to use the buffering tools in ArcGIS to generate various styles of water markings, including waterlines.

Regardless of which software is used to generate the lines, some smoothing and manual cleanup may be required, as some software packages can give the lines too jagged an appearance. An application of human judgment is necessary to round out the sometimes harsh mathematics of the computer (Figure 4).

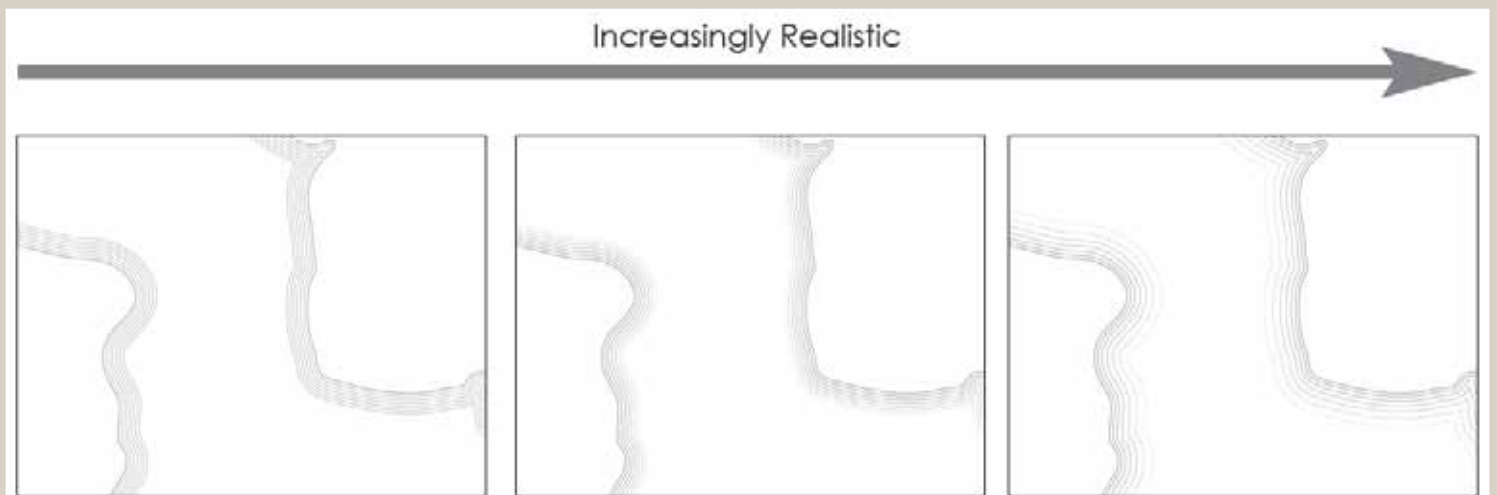
Figure 4. Smoothing out digitally generated waterlines. The sharp corners on the left image have been manually adjusted on the right image.



DESIGN DECISIONS

Making the waterlines themselves is quick and straightforward. There is, however, a great deal of room for fine-tuning; decisions must be made concerning the number of lines, their spacing, their weight, and their color. These decisions determine whether the waterlines feel more like a cartographic symbol for water, or like actual water. At the realistic end of the scale, the symbol becomes transparent, leaving the reader seeing waves more than they see lines representing waves (see Figure 5). Where along the spectrum a set of waterline markings lies will be very much based on the needs and aesthetics of each individual cartographic work; very realistic waterlines would clash with the purposefully rough appearance of the right-hand map in Figure 3, for example. What are offered here are points to consider when designing, rather than a set of rules.

Figure 5. Waterlines becoming more realistic in appearance. First a color gradient is added, and then the line spacing is changed from monospaced to one of increasing steps.



Victorian waterlines frequently filled the entire water body, as seen in Figure 1 above. This approach, however, minimizes their advantages over giving a solid fill color to water features. It reduces their subtlety and makes it more difficult to place other map features on the water. It also pushes them away from the realistic end of the scale; the water feature looks more like it is filled with a symbolic texture and less like it has surface waves. Confining waterlines to areas near the shore eliminates these difficulties. How much of a water body is covered by waterlines depends on how many lines are drawn, and how far apart they are spaced.

There are two main options for determining the spacing between individual waterlines: the interval between each line can be constant, or it can increase with distance from the shore (compare the second and third examples in Figure 5). The uniformity of monospaced lines gives them a more stylized appearance, while the increasingly spaced lines suggest a more realistic scene of waves being compressed as they approach the barrier of the shore. A personal rule of thumb for the latter, which gives an aesthetically pleasing result, is to keep increasing the waterline spacing by a factor of 1.3 as they move away from the shore. That is to say, if the first line is drawn 2pt from the shore, the second line would be 2.6pt ($1.3 * 2$) from the first, and the third would be 3.38pt ($1.3 * 2.6$) from the second, and so on. The distance between the shore and the first line is one of the more critical factors. The smaller it is, either for monospace or increasingly-spaced lines, the closer all of the lines will be to the shore, and the sharper the edge between water and land will be (see Figure 6).

Finally, the line weight and color of each individual waterline can be held constant, or it can follow along a gradient. Revisiting the ICA glossary's (1973) definition, we find that they describe waterlines as *lines representing water, drawn parallel with the edge of a water feature, which decrease in proximity and strength away from that edge*. The term "strength" is a bit ambiguous, but it suggests lines becoming fainter or thinner (or both) as they move away from the shore. Doing so lends the waterlines a more realistic appearance; stronger lines reflect the reality of surface waves increasing in height as they approach the shallow water of the shore. It also helps create a smooth transition between the waterlines and the open area in the center of the water body.

THE UNIFORMITY OF MONOSPACED LINES GIVES THEM A MORE STYLIZED APPEARANCE, WHILE THE INCREASINGLY SPACED LINES SUGGEST A MORE REALISTIC SCENE OF WAVES BEING COMPRESSED AS THEY APPROACH THE BARRIER OF THE SHORE

Figure 6 – Each of these two sets of waterlines uses the same line weight, color, and line spacing rate. The one on the left has a harder edge because it starts closer to the shore than the one on the right, leading to a more compact set of lines.



RIVERS

Though it was common practice to do so in the nineteenth century, I believe it is advisable to leave waterlines off of rivers. As said, the lines resemble waves washing up on the shore, but waves do not generally begin in the center of a river and push against the banks². Waterlining rivers creates a cognitive mismatch, detracting from the sense of reality that the technique can convey by directly conflicting with the reader's knowledge of how the world works. That being said, a simple, solid fill polygon for a stream may likewise look out of place when compared with the more detailed treatment given to waterbodies. A different marking device, analogous to waterlines and conveying a sense of linear flow, is needed. The choice and application of such a technique is beyond the boundaries of this essay, but may be addressed in a future one.

FINAL THOUGHTS

Once the painstaking task of highly specialized engravers, waterlining is now simple and straightforward with current software tools. Its rarity in modern work is as lamentable as it is perplexing, given the elegance and clarity that it imbues. This article is written with the hope that an iconic element of Western cartography for over a century will be revived from disuse and find its place once again in our common lexicon.

ACKNOWLEDGMENTS

Two years ago, I had no idea what waterlines were, until my colleague Daniel Reynolds pointed them out on an old USGS topographic map and suggested that I add some to a piece I was working on. A year later, after drawing them on several maps, I still knew nothing about their history, or even what they were called. Fortunately, Paulo Raposo at Penn State knew of Christensen's 2008 paper and sent me a copy, which helped put me on the track to writing this article. I am as well indebted to my many talented colleagues in the UW—Madison Geography Department, with whom it is my good fortune to interact daily, and who have always patiently listened when I wanted to talk about the esoteric subject of cartographic water markings.

²*My colleague Ben Coakley first alerted me to this problem while reviewing a map in which I had waterlined the Mississippi River.*

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THE UNIVERSITY OF WISCONSIN—MADISON ARBORETUM MAP

Located on 1,260 acres in a semi-urban neighborhood in southwest Madison, the UW Arboretum features restored prairies, forests, and wetlands. The Arboretum was established in the early 1930's on reclaimed farmlands and pastures. Its attractions, such as the world's oldest prairie restoration, Curtis Prairie, draw one million visitors annually.

In honor of its 75th anniversary, the Arboretum commissioned an online interactive map of its grounds, facilities and research initiatives. In the last year, the University of Wisconsin—Madison's Cartographic Laboratory, in partnership with Axis Maps, LLC, completed work on this map (<http://uwarboretum.org/map/>). The core project team consisted of staff from these two partners, as well as the Arboretum itself, but the map would not have been possible without the cooperation and input of the public. The map framework was built in Adobe Flash, while data was processed in ArcGIS and graphic design was done in Adobe Illustrator and Adobe Photoshop.

ENGAGING THE PUBLIC

A primary goal of the Arboretum map was to engage the public from planning to launch. The nature of the final product, a mapping platform that would rely on volunteered geographic information, made it essential to encourage input and feedback from community members who would be most likely to use it. This was a major challenge at the onset because of the diversity of Arboretum staff, volunteers, and visitors. Some Arboretum users see it as a scientific laboratory, some see it as place of recreation, and others as a place to join a community. Thus, in our needs assessment, it was clear that if the Arboretum Map could not be limited to one map interface. Similar to the market research conclusions of Howard Moskowitz in the 1980's (Gladwell 2004)—that there is no one perfect product, just perfect *products*—the Arboretum Map was to have a number of user-centered (Gabbard, Hix and Swan 2008) map interfaces, each geared toward specific user groups. The map would have three main scenario views: “Learn,” “Go,” and “Your Turn” (Figure 1).

When toggling across scenarios, map users would filter map content based on the purpose of their visit. The “Learn” scenario would provide a spatial portal for learning more about the Arboretum soils, plants, and wildlife, as well as the results of recent research conducted in the Arboretum; the “Go” scenario would provide tools and information for planning a visit to the Arboretum, whether to run, bike, or ski; and the “Your Turn” scenario would allow users to contribute to the map in their own way, by posting photos and short narratives on experiences in the Arboretum to share with the community. While a user-centered design approach was used for each map scenario, we also aimed not to limit users to a certain role, but rather to dissolve the boundaries among roles, using certain data and functionalities of the map to bridge the different user groups.

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Figure 1. The three main scenarios for the Arboretum map: “Learn”, “Go”, and “Your Turn”.

THE COMMUNITY MEETING WAS A CRUCIAL STEP IN PROMOTING PUBLIC PARTICIPATION IN THE CREATION AND MAINTENANCE OF THE ARBORETUM MAP

The structure and layout of the map were set up for the community who would be primed to use it. But in order for the map to succeed, we needed to foster as much buy-in as possible up front. We wanted to encourage users to make the map theirs and return to it often to see and contribute to its evolution. To that end, the Arboretum hosted a community meeting while the map was still in development. People of all backgrounds and interests were invited through established Arboretum communication channels. Approximately thirty people were in attendance while the overarching mapping technology and an Arboretum map prototype were introduced. A lively discussion followed, concerning the design and focus of the map. Some suggested using the map to delineate where Arboretum volunteers would meet to do their work. Others impressed the importance of the time sensitivity of certain features that should be mapped—flowers in bloom, migrating birds, and fall foliage were all mentioned as ephemeral features.

The community meeting was a crucial step in promoting public participation in the creation and maintenance of the Arboretum map. Some attendees thought of the meeting as a demonstration of new technology and not an opportunity to share their vision of the Arboretum. But by the end of the meeting, many left with clear ideas on ways to contribute: some would contribute through the collection of additional spatial datasets, and others through the composition of narratives meant to accompany map layers. This played to a main strength of VGI, that those who are immersed in the environment being mapped can provide valuable geographic information that could not be acquired otherwise (Flanagin and Metzger 2008). In an effort to narrow the digital divide, channels were established to allow community members of all technical abilities to contribute. We encouraged those with less technical ability to communicate directly with Arboretum staff. For those more technologically inclined, a Wiki was set up as a data depot for community-generated content. With the feedback and continuous flow of data from the Arboretum community, the production of the map continued as a much larger effort.

CONTRIBUTIONS FROM THE COMMUNITY

The Arboretum community is extremely active. It is full of photographers, bird-watchers, and clubs for all kinds of naturalists. It was important during the development of this map to allow these sub-communities to contribute their own unique Arboretum data and experiences. Contributions from

experts in the community fostered buy-in and relinquished project cartographers from the need to become experts in subjects related to the Arboretum.

Many community members contributed information at the start of the project to seed the map; for example, a number of community members offered up photographs and datasets for the map. Others helped with descriptive text and the quality assurance/quality control (QA/QC) of data. Suddenly, thanks to a crowd of interested community members, certain data layers on early versions of the map that were assumed accurate were being corrected and updated.

Additional data that we would not have necessarily incorporated otherwise also was acquired through volunteered information from Arboretum community members. Wisconsin has a rich history of Native American burial and effigy mounds, eighteen of which are located in the Arboretum area. Traditionally on a project of this kind, if something of this nature were to be incorporated at all, a “team member” would be responsible for mapping these mounds. But by tapping into the knowledge and expertise of the public, our “team” was much bigger than those employed by the project. Instead of being limited to a stock shapefile or having to go out and survey the mound locations manually, we were able to add a community member’s hand-drawn sketch of effigy mounds for the “History” section of the “Learn” scenario of the map (Figure 2). The inclusion of analog user-generated content opened potential authorship to an even larger group of people, and as a result, more content was generated. The buy-in that was so important from the map’s inception had grown into something that gave user groups confidence in their contributions to the map.

Though cartographic or technological expertise was not a requirement of contributing community members, the map did benefit from the feedback of those who had domain-specific expertise. In one instance, a community member close to the project also happened to be a soil scientist. This community member generously volunteered to develop a generalized classification scheme for our soils layer based on information we had collected from the Natural Resources Conservation Service (Figure 3). In so doing, he provided us with scientific reasoning for the map’s soil representation. An enormous benefit of how the map was built is that we are able to engage experts, through channels of communication established at the community meeting, on everything from history to biology.

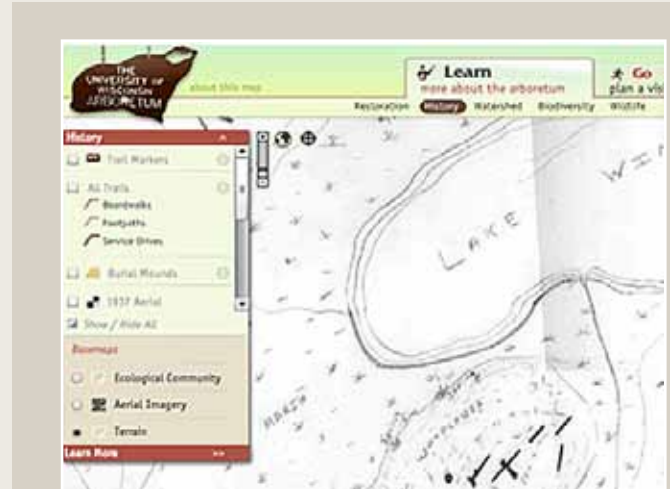
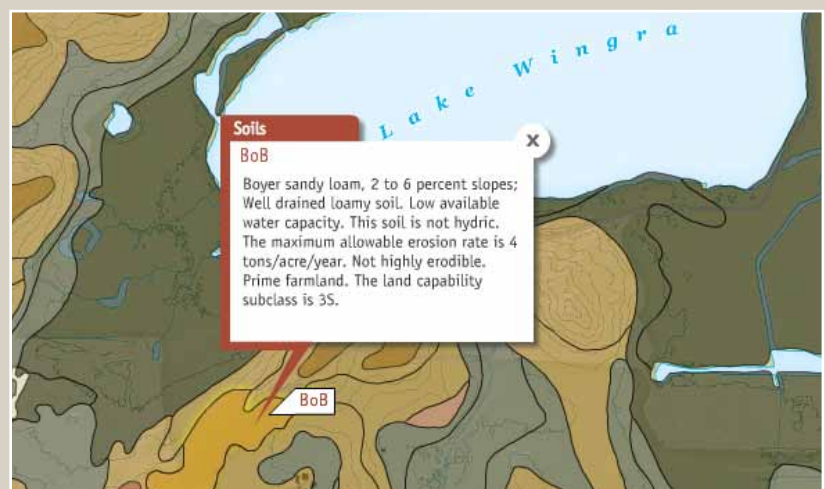


Figure 2. A custom, hand-drawn map of effigy mounds incorporated in the Arboretum map.

Figure 3. A soil color scheme developed by an Arboretum community member.



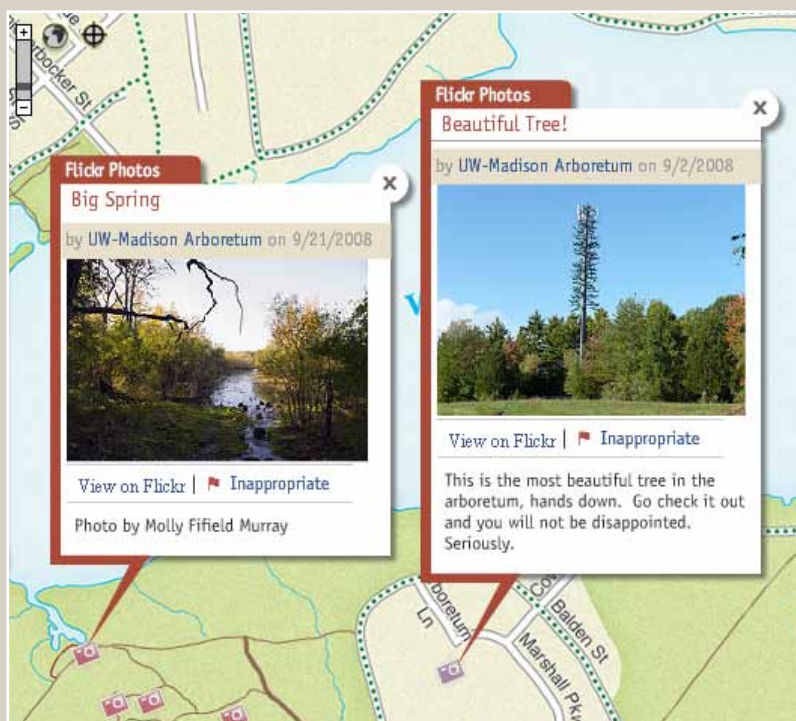
CONTROLLED CONTRIBUTIONS

WHILE IT WAS
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FOR PUBLIC
CONTRIBUTIONS

Nearly everyone has the ability to make a map, whether cognitively, on a napkin, or with high-tech software (Wood 2003). While it was important for the core team to assert cartographic expertise, it was equally important to make room for public contributions. We accomplished this through controlled inclusion of user contributions through specific online services. The contributions were controlled in basic ways (e.g., geographic extent, color choices, appropriateness of topic) to keep the map from becoming cluttered or incoherent. One of the more novel approaches taken in the development of this project was to allow users to add their own experiences to the map via Flickr and Google My Maps. There were two main benefits of this approach. First, we tapped into non-expert services to which many people likely had been exposed. Second, we offloaded development of these tools, so we did not need to build in a tool for uploading photos or drawing features. This aspect of the Arboretum Map is a mashup designed specifically for VGI. These tools make it possible for interested members of the public to become geographic sensors (Goodchild 2007b) for the Arboretum Map, giving it breadth and depth that a professional survey could not achieve.

The “Your Turn” scenario of the Arboretum map was designed for this purpose; it is the key to maintaining community ownership of the map. It allows community members to refer to expert content as needed, and reflect on their personal Arboretum experiences in a public forum. Users are encouraged to go to their Flickr accounts and apply a unique tag to

Figure 4. “Appropriate” (left) and “inappropriate” (right) user-generated photos. The “appropriate” photo shows a spring located on the Arboretum grounds; the “inappropriate” photo is labeled “beautiful tree!” but features a cellphone tower disguised as an evergreen located off of the Arboretum grounds.



geo-located photos taken within the Arboretum. Each time the Arboretum Map loads, it searches the Flickr server for photos with this tag and displays them in real time. Users are also given the ability to police content. In order to keep the map's photos from getting too off topic, we allow users to flag "inappropriate" volunteered content and alert the map's curators of its existence (Figure 4). This is similar to the "gate-keeping" model used by Craigslist, Wikipedia, and others for managing user-driven content.

In addition to adding user-generated photos to the maps, we allow users to contribute other experiences in the form of spatial data. For many years, Arboretum naturalists have been recording their observations throughout the seasons, forming a valuable phenological record of Arboretum events. These notes contain a wealth of information on what visitors can expect to see and enjoy at the Arboretum at any particular time of the year. We wanted a way to tap into this knowledge base and view it on the map. The "Observations" section of the "Your Turn" scenario of the map allows users to make their observations available to the entire community in a few simple steps. If the user has an account with Google, the My Maps interface can be used to draw points, lines, or polygons to represent user experiences at the Arboretum. If a user has heard a particularly unique bird call in an area (Figure 5), decided on the best hiking route for beginners, or found a really great spot for fall foliage photos, they can follow directions for drawing them in Google My Maps. Then, as with the Flickr photos, these features will be added to the map.

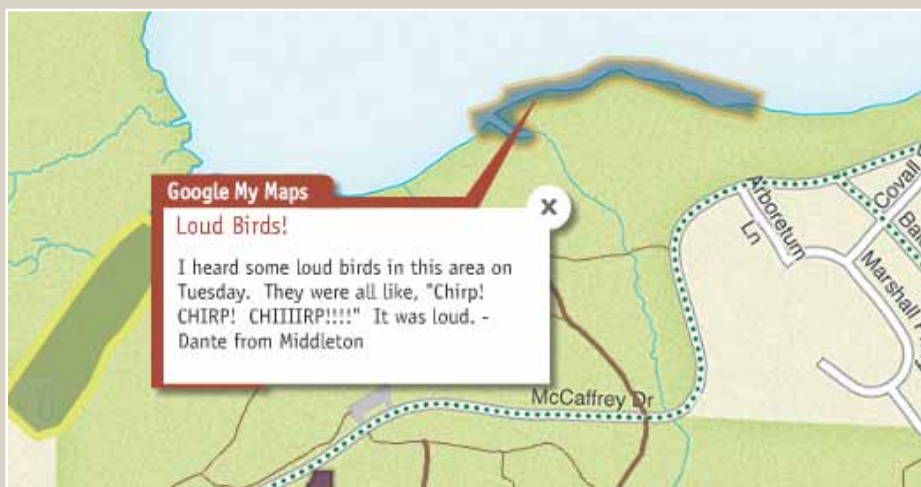


Figure 5. A user-generated experience on the Arboretum map via Google My Maps.

WE PROVIDE THE CARTOGRAPHY

Not all authoring power can be relinquished to the public. Just as Google employs user-generated content and not user-developed search algorithms, we have allowed for user-generated experiences in the Arboretum Map, but not user-generated cartography. Though some studies have shown that active contributors in social computing are most often "well-meaning" (Goodchild 2007b), there is still considerable concern surrounding the credibility and veracity of volunteered geographic information (Flanagin and Metzger 2008). To extend digital map-making tools to the public may be a wholesale positive in a vacuum, but in application, it could prove problematic. Every member of the public cannot be expected to adhere to the same cartographic principles, nor can all "citizen sensors" be expected to agree on what is "appropriate" and what is "inappropriate" for the map. To that end, the Arboretum Map represents an attempt to democratize cartography, but only

in a specific way. We aimed to cultivate a major benefit of democratizing cartography: to increase the public’s understanding of how maps, and the map-making processes they represent function as a means to communicate phenomena on the ground (Rød, Ormeling, and Elzakker 2001). While doing this, however, we limited the map-users’ ability to drastically alter the map’s mission.

WHILE FOSTERING
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We were aware of these issues up front and aimed to keep all of our map content relevant and clear. While fostering public participation in the creation and maintenance of the Arboretum Map, we also asserted our expertise as cartographers. So while the style and appearance of base map tiles were discussed with the community, they were designed first and foremost based on cartographic principles. Similarly, layer combinations and organization were controlled by a team of cartographers. For example, scientific content about biodiversity was not made available to users under the “Go” scenario—the idea being that if someone is planning an afternoon jog, he or she may not want to be bothered with the locations of invasive species on the route.

Allowing users to draw in My Maps presented a unique cartographic dilemma, however, and this is where the assertion of cartographic expertise really came in to play. Should we allow users to submit their personal experiences in the form of a 70-color line drawing of their favorite paths? We thought not. Instead, we opted to develop a 21-color palette that was compatible with the pre-designed Arboretum map base tiles. This palette now acts as a filter, or on-the-fly ‘map brewer’ (Brewer 2003), forcing all color options from My Maps to the closest approximation that will suit the base tiles in the Arboretum map (Figure 6). So, if users draw their points, lines and polygons in bright red, hot pink, or a sickly yellow, the Arboretum map reads their RGB values and automatically converts them to more appropriate colors for the map. In essence, we give the users a general choice of color, but we guide that choice based on simple cartographic principles.

Figure 6. The Google My Maps Color Palette (left columns) and its Arboretum mapcolorequivalents (right columns).



SETTING THE MAP FREE

The Arboretum map was built using technologies that are not familiar to all Geographic Information Scientists and Cartographers, let alone public users of online maps. Adobe Illustrator and Photoshop are relatively mainstream, but add Flash, KML, and XML to the mix and things tend to get complicated for most people. Because our aim was to retain users as contributors and hand off the map to Arboretum staff as curators, we recognized that it was imperative to build a flexible and approachable infrastructure for the map. This way, when the map was “complete” from our point of view, its life was really just beginning.

By marrying Flash with XML, we were able to eliminate the need for the map curator to be a programmer. Aside from major design changes, the map can be maintained and updated in a simple text editor. Layer visibility, order, and structure can be altered, narratives can be edited, and hyperlinks added all outside the Flash integrated development environment. One example of this could be the mapping of a “Hike of the Month.” At the same time, additional layers can be developed and added through several methods: Google My Maps, manual KML production, or a KML conversion tool (from any kind of spatial database). Technically, the map curator does not even need to own (let alone employ) professional GIS or graphics software.

The flexible infrastructure we created allowed us to literally set the map free when it was complete. All future updates and maintenance to the map can be tackled easily by the Arboretum staff, pushing ownership and authorship of the map even further away from the experts and toward the community.

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CONCLUSION

The University of Wisconsin—Madison Arboretum has a diverse and active community at the ready to help with the Arboretum’s mission. When embarking on this project to make a map for the Arboretum’s 75th anniversary, it was our goal as cartographers to tap into that community as much as possible. This would both relieve us of the expectation of expertise in multiple disciplines and give the public a sense of ownership and authorship of the Arboretum map.

Our efforts were just a small part of a growing trend in spatial technology to find a happy medium between professionally-generated content and crowd-sourced data. Google Maps has begun to allow users to edit locations, relying partially on local knowledge over remotely placed technicians. Google Goggles combines

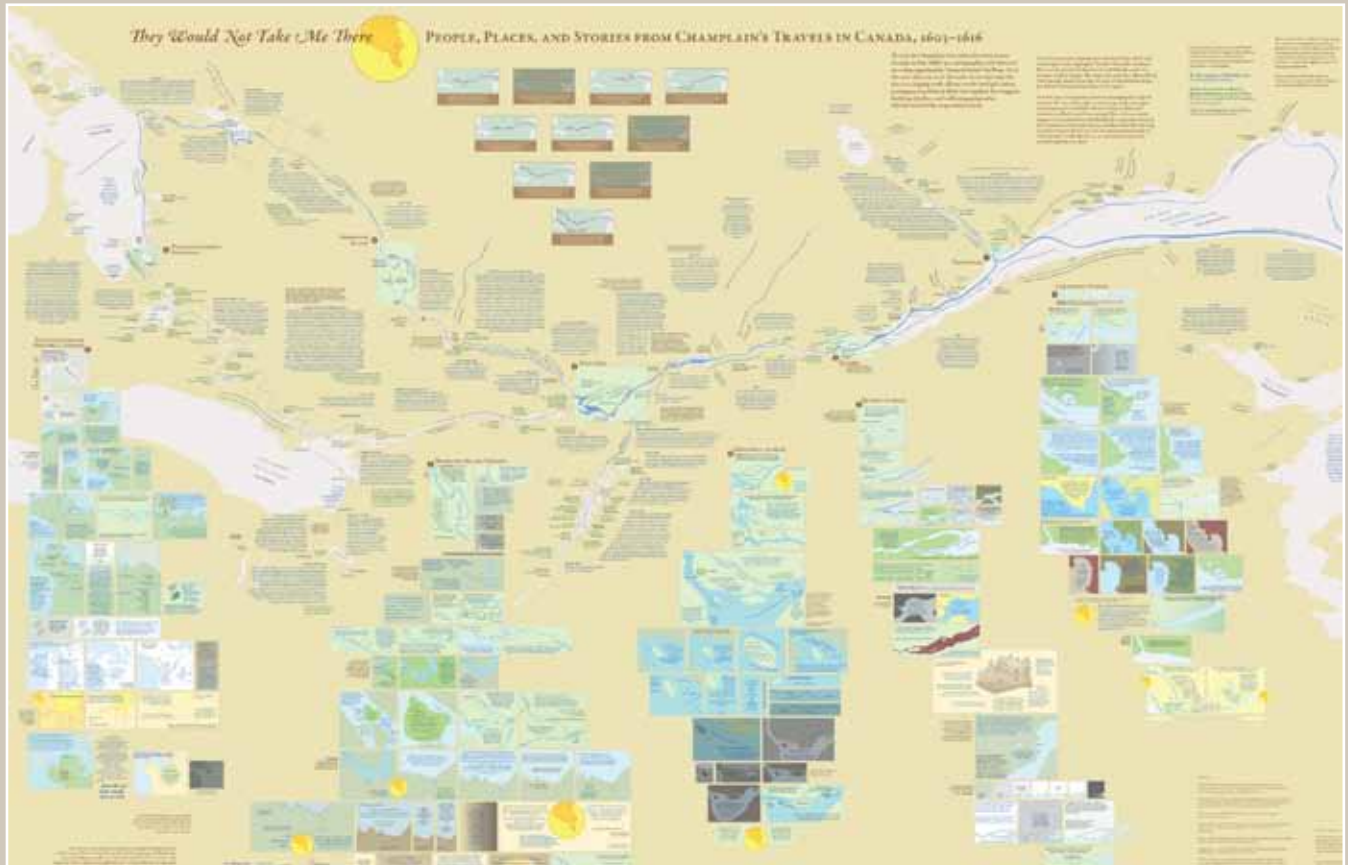
professional image search technology with user-generated reviews, allowing users the ability to search for comments and reviews on products and places by simply taking a snapshot. Bing is also following this model, now merging their street-view level data with Creative Commons imagery via Flickr, creating a seamless three-dimensional environment from multiple sources. Many spatial tasks that had previously been reserved for highly motivated technicians have been opened up to a broader user base; editing OpenStreetMap, for example, once a highly complex task, has been simplified for the masses by developers at CloudMade. Edits can now be made via an uncomplicated graphical user interface called Mapzen.

The new University of Wisconsin—Madison Arboretum map strives to embrace this new trend. It is not loaded explicitly with expert content telling users how they “should” experience the Arboretum. By allowing users to post their own photos and experiences (and allowing a committee of user-gatekeepers to decide whether those photos are relevant), the map becomes a dynamic and rich environment for experiencing the Arboretum in ever-new and novel ways. Unless tapped into a live data feed, even animated and interactive maps become stagnant and outdated quickly after publication. But by giving the Arboretum community ownership of this map, it will continue to be as active and vibrant as the community that makes it.

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over time. These panels were designed to encode story elements using different techniques with type, color, and scale, in order to express isolation, seasonality, danger, despair, death, hope, and survival. Champlain's voice is quoted directly from his journals (typeset in blue), imagined Native voices respond (in green), and the cartographers' voice (in black) moves the story along. The map is published on two sides; English on one side and French on the other. Native placenames are translated on both sides. Some examples follow.



They Would Not Take Me There; People, Places and Stories from Champlain's Travels in Canada, 1603–1616. Paper map is 39 x 59 inches, folded to 8 x 10 inches, or available rolled. Published by The University of Maine Canadian–American Center, Orono, Maine, USA. ISBN 978-0615-23159-4. Retail \$14.99.

INTRODUCING THE READER

The predominant direction of Champlain's travels was a push westward. This is problematic because people want to 'read' the map from left to right, or west to east. To address this counter-intuitive issue, the upper right of the map is used to introduce the reader to the map as a whole, immediately following the title. The introduction is followed by an invitation from the cartographers, which embeds a legend based on type and color, and is read as narrative instead of a conventional abstract legend. It ends with the introductory statement by Champlain, as he first sights land in 1603. From here, the reader is well positioned to understand the maps use of typography as voice, and to enter the landscape with Champlain, for the first time, heading west.

In this map, we invite you to travel with Champlain by following the blue ribbons of his routes, upriver and over land, listening to his stories and imagining his experiences in each place.

The blue passages are Champlain's voice from his published journals.

Native voices speak in an imagined dialogue, indicated by green text. When Native voice is paraphrased by Champlain, it is shown in quotes.

When we, the cartographers, have something to add, our voice is in black italic text.

There are also five numbered stops along the way where Champlain spent long periods of time. Follow these numbers to their matching stories, where you can read of Champlain's adventures as they unfold over time through the panels of the sequential insets.

You will discover that the separate sequences connect when stories begin in one location and move to another.

Place names are also markers in this landscape.

Native place names are in green; if their English translations are known, they are in green italic. These place names come from the Cayuga, Montagnais, Algonquin, Western Abenaki, Mi'kmaq, and Wendat languages. We have included only some of them to serve as guides and reminders, though in reality the whole landscape is an intricate web of Indigenous toponyms.

Blue indicates places renamed by Champlain. A lighter shade of blue italic indicates a place renamed by Europeans prior to Champlain.

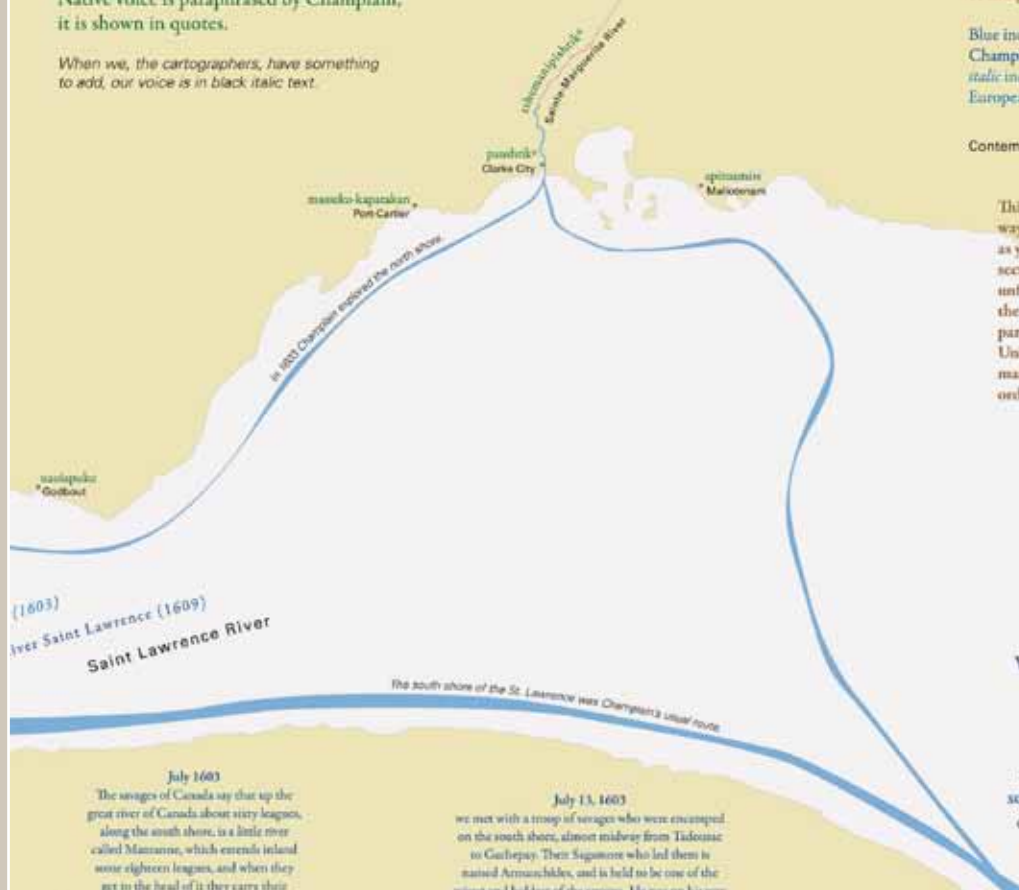
Contemporary place names are black.

This map can be read in many ways. We hope you will read it as you would a novel, in sections over time. As the unfamiliar becomes familiar, the characters will become part of your imagination. Unlike a novel, you can read in many directions and in any order you wish.

Champlain's adventures begin in the east with his arrival on May 21, 1603.

MAY 21, 1603
we sighted Gaspé, a very high land,

and began to enter the said river of Canada, skirting the south coast as far as Mantanne, distant from Gaspé sixty-five leagues...



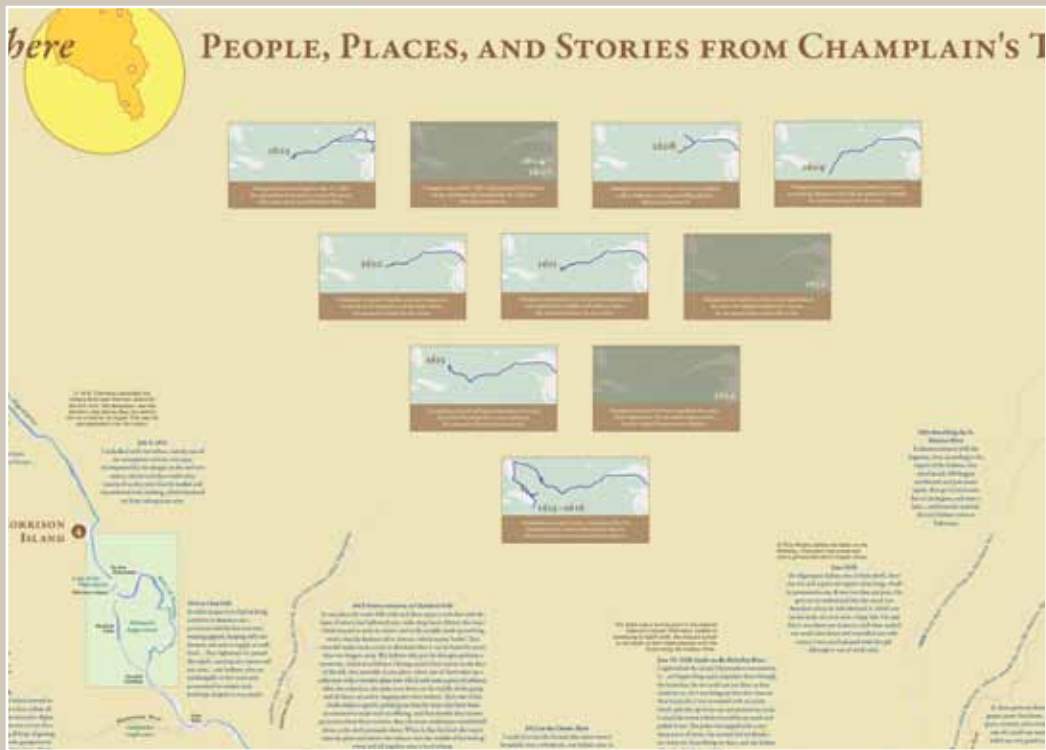
July 1603
The savages of Canada say that up the great river of Canada about sixty leagues, along the south shore, is a little river called Mantanne, which extends inland some eighteen leagues, and when they get to the head of it they carry their

July 13, 1603
we met with a troop of savages who were encamped on the south shore, almost midway from Tadoussac to Gaspé. Their Sagamore who led them is named Armanchibles, and is held to be one of the wisest and boldest of the savages. He was one of the

Map typography as voice: Champlain's voice is in blue, imagined Native voices in green, and the cartographers' voices in black.

TIME AND PLACE

A series of small multiples was designed to orient the reader to both time and place during the thirteen years of travelling illustrated in the map. Champlain's routes often overlapped, and in some seasons he travelled back and forth several times between the same places. This level of detail was removed from the main map, although specific dates were used to help the reader understand from which trip a specific quote derived. Readers then may refer to the small multiples for a sense of the overall journey extent for each year. Some years Champlain did not return from France; those years are shown as dark panels with no route. Overall, the locator maps illustrate Champlain's continued goal of pushing farther west and north with each year.



Small multiples showing the extents of each of Champlain's trips to Canada.

Left: The complete set of small multiples for 1603–1616.

Below: Travel extents for 1610, 1611, and 1612.

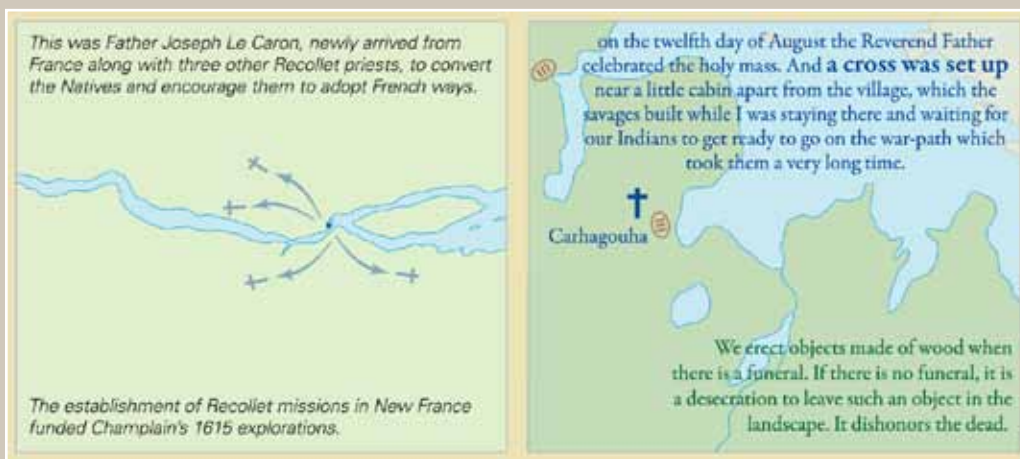


TYPE AS A DESIGN ELEMENT

Many of Champlain's descriptions have to do with the river currents, and many of his stories unfold on the water. In this series of panels where the story occurs, type was used to reinforce the current as it flows along with the story. The type also locates the place where the description occurs, as in the following example where Champlain describes what is now called the LaChine Rapids. The word 'force' is used as a graphic element to symbolize the swirling rapids. Champlain continues to tell the story of a drowning and the type is placed to suggest drifting with the current. Scale and color become design elements as well: the scale changes to reinforce the helplessness of the situation. As Louis drowns, the color palette darkens, and water returns to blue in the final panel.

NATIVE VOICE

Native voice was introduced to the map as a counterpoint to Champlain's voice. This voice was represented in several ways based on Champlain's interpretation, ethnohistorical interpretation, and placenames. In the first example, the ethnohistorical record was used to create a response to Champlain's symbolic act of erecting a cross at a village site. This practice was interpreted differently by the two cultures, and the map provides both views. In the second example, the Native placenames delineate a peopled landscape, in contrast to Champlain's own maps of emptiness in the same spaces. Many of the placenames remain in use today, a lasting legacy that stands in contrast to Champlain's practice of renaming places.



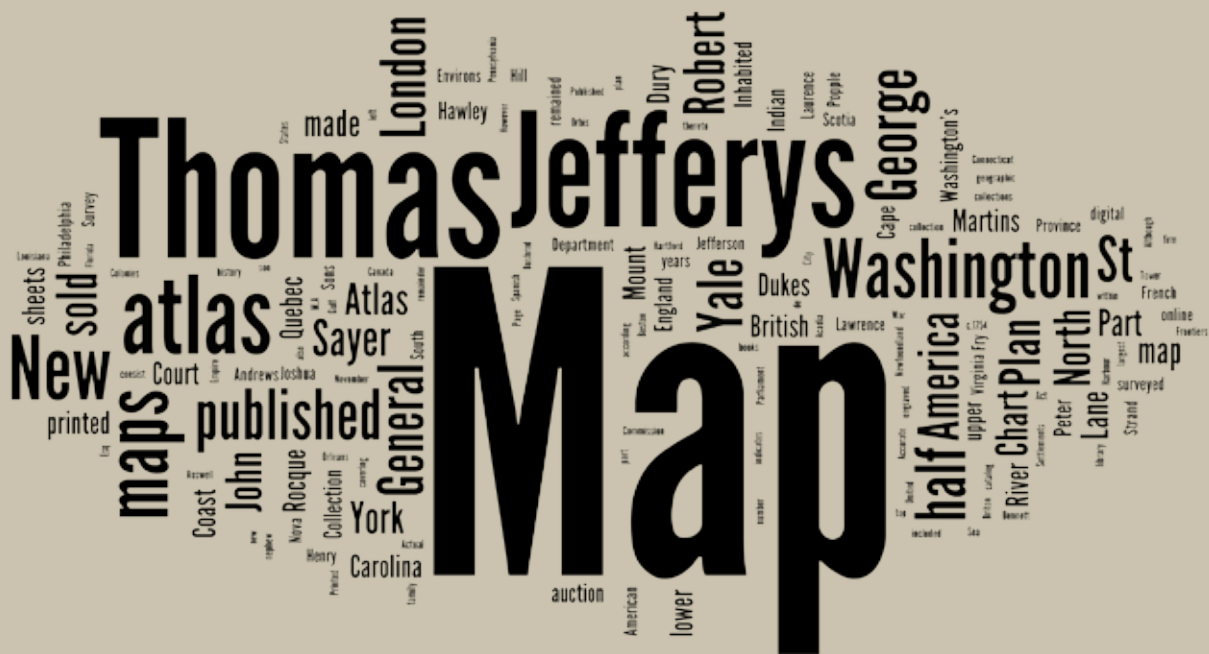
The inclusion of Native placenames adds context to a landscape that Champlain often refers to as empty or barren. The reader can see where several names have remained as modern placenames, such as Bobcaygeon and Couchiching (below).



George Washington's American Atlas

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Sterling Memorial Library
Yale University
130 Wall St.
New Haven, CT 06520



INTRODUCTION

The Yale Map Department has the largest collection of maps in Connecticut and one of the largest university collections in the United States. Its collections are geographically comprehensive and consist of over 255,000 map sheets, of which 11,000 are rare maps (pre-1850). The collection also includes 30 globes, 3,000 atlases, and 900 cartographic reference books and journals. There are currently about 1,300 digital images of maps available through Orbis, Yale University Library's online public access catalog (<http://orbis.library.yale.edu>). Users can limit searches to the Map Collection and search "online map" as a keyword to find all records with digital maps.

In 1970, the Yale Map Department purchased a composite atlas that contained 43 eighteenth century maps that belonged to General George Washington. These maps have remained largely unknown and hidden in the Collection for the past 40 years, until the atlas was rediscovered during an inventory a few years ago. While the atlas is being conserved and rebound with a new cover of a larger size, the individual maps have been digitized and posted to Orbis. Also, a book based on these maps by author and Yale alumnus Barnet Schechter is due to be published in November 2010. It is hoped that these new developments will spark more interest in and analysis of these important maps of American history.

CONTENTS OF THE ATLAS

The atlas consists of 43 map sheets covering the geographic region of colonial North America. The index and page numbering of the atlas indicate a total of 44 map sheets in the atlas. However, the number 21 was skipped over by mistake, resulting in 43 sheets. The first three map sheets consist of small-scale general maps of North America. The remainder of the atlas begins with a plan of Quebec, then runs in a geographic sequence from north to south, ending with a plan of New Orleans.

Although it has a similar title, *George Washington's America Atlas* is not *The George Washington Atlas* originally published by the George Washington Bicentennial Commission (edited by Lawrence Martin) in 1932. The atlas by the Commission reproduced eighty-five maps: twenty-eight made by George Washington himself, seven used and annotated by him, eight made at his direction, and the remainder associated with him in some other way.

Although George Washington himself was a surveyor and cartographer, he made none of the maps in *George Washington's America Atlas*. These maps were in George Washington's possession and may have been used to make decisions in our country's early history. Most of the maps in the atlas are British publications from London ranging between 1733 and 1775 and covering historical events from the French and Indian war to the American Revolution. Maps in the atlas come from a range of cartographers, such as Henry Popple, John Rocque, Joshua Fry, and Peter Jefferson, but a significant number of them were made, engraved, or published by Thomas Jefferys, Geographer to King George III of Great Britain.

THESE MAPS
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HISTORY

ATLAS MAP LIST

- MAP 1:** *A General Map of North America, Northern Part.* John Rocque; published by M.A. Rocque in the Strand, c.1754–1761.
- MAP 2:** *General Map of North America Southern Part.* John Rocque; published by M.A. Rocque in the Strand, c.1754–1761.
- MAP 3:** *Canada, (Partie de L'Amérique Septentrionale qui comprend Le Nouvelle France ou le Canada).* Sr. Robert de Vaugondy, 1755.
- MAP 4:** *Environs of Quebec. A Correct Plan of the Environs of Quebec and of the battle fought on the 13th September 1759.* Published according to Act of Parliament by Thomas Jefferys, the corner of St. Martins Lane, Charing Cross, 1759.
- MAP 5:** *An Authentic Plan of the River St. Laurence (to William Pitt).* Thomas Jefferys, 1755.
- MAP 6:** *A Plan of Quebec.* E. Oakley, 1759.

- MAP 7:** *An exact Chart of the River St. Laurence...for Navigating the river to Quebec.* Thomas Jefferys, for Robert Sayer, 1755.
- MAP 8:** *A Chart of the Gulf of St. Laurence.* Thomas Jefferys, published by Robert Sayer, 1755.
- MAP 9:** *A General Chart of the Island of Newfoundland.* Thomas Jefferys, published by Robert Sayer, surveyed by James Cook and Michael Lane, 1755.
- MAP 10:** *A General Chart of the Banks of Newfoundland.* Thomas Jefferys, published by Robert Sayer, 1755.
- MAP 11:** *A Chart of the Coast of Labrador.* Thomas Jefferys, 1755.
- MAP 12:** *Map of Nova Scotia or Acadia (top half).* London, printed and sold by A. Dury in Dukes Court, St. Martins Lane, 1768.
- MAP 13:** *Map of Nova Scotia or Acadia (lower half).* London, printed and sold by A. Dury in Dukes Court, St. Martins Lane, 1768.
- MAP 14:** *A Plan of the Island of St. John.* London, printed and sold by A. Dury in Dukes Court, St. Martins Lane, surveyed by Capt. Holland, 1775.
- MAP 15:** *A Large and Particular Plan of Shegnekto Bay.* Thomas Jefferys, printed for Robert Sayer in Fleet Street and Thomas Jefferys in the Strand, 1775.
- MAP 16:** *A Chart of the Harbour of Halifax, in Nova Scotia.* Thomas Jefferys, 1775.
- MAP 17:** *An Actual Survey of The Sea Coast from New York to the I. Cape Briton (upper half).* London, sold by I. Mount, T. Page, and W. Mount, Tower Hill, London, 1768.
- MAP 18:** *An Actual Survey of The Sea Coast from New York to the I. Cape Briton (lower half).* London, sold by I. Mount, T. Page, and W. Mount, Tower Hill, London, 1768.
- MAP 19:** *A Map of the British Empire in America with the French and Spanish Settlements adjacent thereto (upper half).* Henry Popple, 1733.
- MAP 20:** *A Map of the British Empire in America with the French and Spanish Settlements adjacent thereto (lower half).* Henry Popple, 1733.
- No 21: no map**
- MAP 22:** *The Seat of War in New England, by an American Volunteer with the Marches of the Several Corps Sent by the Colonies Towards Boston with the Attack on Bunkers Hill.* London, printed for Robert Sayer, and J. Bennett, 1775.
- MAP 23:** *A Map of the Most Inhabited Part of New England (lower half).* Thomas Jefferys, 1774.

- MAP 24:** *A Map of the Most Inhabited Part of New England (top half).* Thomas Jefferys, 1774.
- MAP 25:** *Boston Harbor.* Published according to Act of Parliament by J.F.W. Des-Barres Esq., 1775.
- MAP 26:** *A General Map of the Middle British Colonies in America [with Seats of the Indian Nations].* Thomas Jefferys, published by Lewis Evans, Philadelphia, 1775.
- MAP 27:** *A Map of the Province of New York with Part of Pennsylvania and New England.* P. Andrews, published by A. Dury in Dukes Court, 1775.
- MAP 28:** *A Map of the Province of New York, (to the Right Honorable Sir Jeffery Amherst).* P. Andrews, 1775.
- MAP 29:** *A Plan of the City of New York and its Environs.* P. Andrews, sold by A. Dury in Dukes Court, St. Martins Lane, surveyed by John Montessor, 1775.
- MAP 30:** *A Plan of the Town and Fort of Carillon at Ticonderoga: with the attack made by the British Army Commanded by General Abercrombie.* Thomas Jefferys, 1758.
- MAP 31:** *A Map of Pennsylvania Exhibiting not only the improved parts of the Province, for Thomas and Richard Penn Esq.* Printed for Robert Sayer and J. Bennett, 1775.
- MAP 32:** *A Map of the most Inhabited part of Virginia (Joshua Fry and Peter Jefferson) (lower half).* Thomas Jefferys, 1775.
- MAP 33:** *A Map of the most Inhabited part of Virginia (Joshua Fry and Peter Jefferson) (upper half).* Thomas Jefferys, 1775.
- MAP 34:** *An Accurate Map of North and South Carolina with their Indian Frontiers (upper half).* Thomas Jefferys, 1775.
- MAP 35:** *An Accurate Map of North and South Carolina with their Indian Frontiers (with insets of Hilton Head and the Harbour of Charlestown).* Thomas Jefferys, 1775.
- MAP 36:** *A Map of South Carolina and a Part of Georgia containing the whole sea coast.* Thomas Jefferys, 1757.
- MAP 37:** *North Carolina.* Thomas Jefferys, 1757.
- MAP 38:** *A Survey of the Coast about Cape Lookout in North Carolina.* Thomas Jefferys, 1756.
- MAP 39:** *A New and Exact Plan of Cape Fear River from the Bar to Brunswick.* Thomas Jefferys and Edward Hyrne, 1749.
- MAP 40:** *A View of Savannah as it Stood the 29th of March 1734.* Peter Gordon, engraved by P. Foudrinier, 1750.

MAP 41: *A Chart of the Entrance into St. Mary's River taken by Captain W. Fuller in November 1769.* Thomas Jeffreys, 1769.

MAP 42: *The Coast of West Florida and Louisiana / The Peninsula and Gulf of Florida or Chanel of Bahamas with the Bahama Islands.* Thomas Jefferys, 1775.

MAP 43: *Course of the River Mississippi.* Printed for Robert Sayer in London, 1765.

MAP 44: *Plan of New Orleans the Capital of Louisiana.* Thomas Jefferys, 1759.

ATLAS PROVENANCE

Having no biological children, General George Washington devised his estate of Mount Vernon, which included his library, to his nephew Bushrod Washington in Virginia. A portion of Washington's library, which included the atlas, was then left to John A. Washington, the nephew of Bushrod, when he died in 1829. John then left the atlas to his son, also named John, who in turn bequeathed it to his son, Lawrence Washington.

The atlas remained within the Washington family until it was sold, along with other books owned by Lawrence Washington, at an 1876 auction in Philadelphia held at the firm of M. Thomas & Sons. An inscription at the front of the atlas dating from its sale at the 1876 auction reads: "From the Library of Genl Geo Washington Sold by M Thomas and Sons Nov 28th 1876."

The firm of M. Thomas & Sons was destroyed in a fire six years later. However, Yale holds a copy of the auction catalog, which indicates that the atlas was sold as Lot 104 for \$26. An article in the *Philadelphia Inquirer* published the day after the auction indicates that the buyer of the atlas was "General Joseph Roswell Hawley." Hawley was an owner of the *Hartford Courant* newspaper, a Civil War General, Governor of Connecticut, United States Congressman and Senator, and received a degree from Yale in 1888. The atlas remained within the Hawley family until Senator Hawley's daughters (Mrs. Louis L. Coudert and Miss E.L. Roswell Hawley, of Hartford) sold it to the Yale Map Collection in 1970, which was made possible through a grant from the Acorn Foundation of New York and was given in memory of the late Mrs. Arthur W. Butler of New York City—a longtime friend of the Yale Map Collection and one of its most generous supporters.

ACCESS

A digital version of the Yale George Washington Atlas can be accessed via jpeg2000 images from the Yale Map Department web site at:

http://www.library.yale.edu/MapColl/print_online_george_washington_atlas.html

THE ATLAS
REMAINED WITHIN
THE WASHINGTON
FAMILY UNTIL IT
WAS SOLD...AT AN
1876 AUCTION IN
PHILADELPHIA



Map 22 of the George Washington Atlas: The Seat of War in New England, by an American Volunteer with the Marches of the Several Corps Sent by the Colonies Towards Boston with the Attack on Bunkers Hill. London, printed for R. Sayer and J. Bennett, 1775.

One of the important considerations you will need to address as you decide to go out on your own is how to organize the business legally. For small cartography shops (in the United States), you are essentially choosing between four types of organizations:

1) SOLE PROPRIETORSHIP

This is the most common form of filing for very small start-ups. Advantages include the ease of creation and the low costs of formation. However, one significant disadvantage of the sole proprietorship is that you may be exposed to substantial personal liability if your business should ever be unlucky enough to be sued or run into debt.

2) LIMITED LIABILITY PARTNERSHIP (LLP)

When two (or more) individuals organize a company, an LLP will help to structure all of the terms, conditions, and ownership that will be applied to both assets and liabilities (the splitting of profits and how the firm might be dissolved should it disband). It provides better protection from personal liability than a sole proprietorship (including the provision that any one partner cannot be held responsible if the others misbehave or are negligent), and is simpler and more affordable to establish than an S-Corporation. It does not provide the same level of protection from personal liability that an S-Corp will.

3) LIMITED LIABILITY CORPORATION (LLC)

This type of filing allows for one or more persons to form a business without full personal liability for business debt. It is cheaper and easier to form than an S-Corporation, and it does more to establish the business as an entity separate from the individual, but does not remove all personal liability if one should ever face legal action.

4) S-CORPORATION

This type of filing completely separates individuals from the business entity, which is fantastic from the standpoint of personal liability. However, it is generally more complicated and expensive to establish than the other forms of organizations, and will often require an attorney in order to set up properly.

Rules for each type of organization will vary from state to state—and everything is different if you are not in the U.S.—so before deciding how best to form your start-up venture, consult with the appropriate parties to determine what will work best for you. Also keep in mind that you need not necessarily stick with one type of organization. You could, for example, start with a Sole Proprietorship and turn that into an LLC or S-Corporation when you have sufficient cash flow.

ONE OF THE IMPORTANT CONSIDERATIONS YOU WILL NEED TO ADDRESS AS YOU DECIDE TO GO OUT ON YOUR OWN IS HOW TO ORGANIZE THE BUSINESS LEGALLY

PROMOTION

Perhaps the most important means of promotion for a cartographic business is a good portfolio; you need a visual way to demonstrate your experience and talents to prospective customers. Of course, this does pose a bit of a chicken-

and-egg problem if you are just beginning. One thing you can do is create a map or series of maps about a subject in which you are interested; however, I personally have found it difficult to get the most out of my skills on projects that are not for a paying (and demanding) client. An alternative would be to produce a map for free for a good cause, like MapGiving (<http://www.mapgiving.org>)

Once you have a portfolio, it is important to add to it over time so that people continue to check it for updates. You can use the full range of social networking options to keep your clients and contacts informed of what is happening—a blog or Twitter-feed would be a very easy way to achieve this.

Paid advertisements can be too much of a hit-and-miss investment. Unless you are really diligent about trying to get the best-scoring keywords, it is quite possible that it will cost you a lot more than it will ever make you.

There are websites, such as Elance and Odesk, that bring together freelancers with people looking to hire freelancers. Typically there are not a whole lot of cartography or GIS related projects on these sites (cartography generally seems to be lumped in with graphic design)—and more freelancers than jobs—so many clients seem to make their selections based more on price than quality.

The best kind of promotion is to have satisfied clients. If a client is happy about what you have done for them, they will tell others about their pleasant experience. If you have a decent sized network of clients who are in regular need of your services, you can even get by on minimal self-promotion.

PRICING

Determining what one is worth is always difficult. Determining what kind of a budget a client has can be even more difficult (and some clients simply have unreasonable expectations). Sooner or later, it will happen that you are not selected for a project because you are too expensive. Whether you want to compete on price is up to you, but in most cases it is better to compete on the quality of your work. One poorly executed job that you do under price restrictions could cost you dozens in the future, while deciding to maintain your pricing would only cost you one now.

One way of getting a rough figure for an hourly rate is to calculate your billable hours per year (52 x 40 minus vacation time, sick time, other planned time off, and time for accounting and acquisition) then take your desired gross income, plus any expenses, and divide the result by those billable hours. For example, if you are looking for a gross income of \$30,000 and have \$10,000 in expenses planned (hardware, software, office supplies, etc.) with an average of 20 billable hours per week, you would need to have an hourly rate of \$38.46. Keep in mind that even when you are working full days, you will hardly ever get 40 billable hours per week.

One of the most fundamental things you have to decide is whether to charge on a per-hour basis or a fixed price for a project. Per-hour offers you the highest degree of security. However, clients may not be willing to pay for

the hours you spend considering various design options. In such a case, charging a fixed price would offer them the most security. Of course, it is very important to get as much information from your client as possible when you are in the price quote phase; the more information you have, the more accurate your quote is going to be, and the less chance for surprises afterwards.

Whichever way you choose to bill, it is highly recommended (especially on larger projects) to write up a detailed contract regarding what you will be doing in terms of work and what you will be receiving for that work. Other things that can be covered in such a contract are whether or not you will be allowed to use the resulting map in your portfolio and the point at which the copyright will be transferred (most commonly the copyright transfer would occur at the moment the client pays for the map in full). Another important consideration to make is what would happen if the client cancels the project halfway through. It is common to specify a so-called “kill fee” in the contract.

You can choose either to be paid in full after the project has been finished, or at intervals over the course of the project. The latter is quite common in cases where a custom design is being produced. The client pays 25% to 50% at the start of the project, with the remainder due at the end or other predetermined stages.

*A POINT THAT IS
OFTEN OVERLOOKED
IS THE BALANCE
BETWEEN WORK
AND A PRIVATE LIFE*

BALANCE

A point that is often overlooked is the balance between work and a private life. If work starts to pick up and you put in more and more hours every week (it is very tempting, especially at the start, to take on any job you can to generate income), it is very important to make sure you have enough time, and opportunity, to relax. One thing you can do is always give yourself a “day off”. It helps if you tell family members and friends about what you are doing so that they can offer you moral support when you need it.

FOCUS

Another important decision to make is whether you want to be an all-round business, covering all aspects of cartography, or specialize in a certain type of map product. One theory says that it is better to be very good in one particular type of map than to be somewhat good in all of them. Specialization will also increase your chances of competing successfully with other freelancers. On the other hand, you do not want to be dependent on one type of map or one type of customer. To name one example, many cartographers catering to the real-estate industry have seen a sharp decrease in the volume of work they have been receiving. It is therefore important to add new clients to your roster every now and then and, if you see that business is getting slow, to consider expanding on the kind of maps or services you offer.

TEAM UP OR NOT?

Related to the focus issue is the question of whether you should team up with other freelancers in order to offer a wider range of services (and have a higher capacity for taking on new projects). Of course, the other freelancers in your network can generate business for you, too. If you can get together a network with freelancers that have different skillsets, you will be in a good position to compete with larger organizations.

IN CONCLUSION

These bits of advice are by no means absolute truths, but they seem to work out well for a lot of people. Make no mistake, being a freelancer is a lot of work and comes with a lot of uncertainty—so before you start, make sure you understand all of the consequences. There are also rewards that more than make up for it. These are not limited to just financial rewards; many freelancers enjoy the freedom and flexibility of being their own boss.

*This article is based on a Q&A session held during the 2009 NACIS conference, as well as several discussions on the CartoTalk forum. For more information, we recommend **The Freelance Design Handbook** by Cathy Fishel.*

at <http://www.cartogrammar.com/blog/map-panning-and-zooming-methods/>. Most of these methods are not mutually exclusive, and it is advisable to support multiple types of map browsing in a single map (Roth and Harrower 2008). In this tutorial I focus on three of the most common and efficient methods identified by Harrower and Sheesley (2005): direct manipulation (click-and-drag, or a “slippy map”), zoom box, and navigator window.

Deciding how to implement panning and zooming depends heavily on the design and purpose of the map. If a map does not require much custom design, comprises fairly simple geo-referenced vector data, or needs to be highly extensible or collaborative, then a mash-up approach with mapping APIs such as Google Maps (or services built on top of them) may be the simplest way to incorporate panning and zooming along with other built-in functionality. If the map is only a raster image and otherwise not interactive, software such as Zoomify (<http://zoomify.com/>) provides an easy solution by automatically generating a panning and zooming interface and breaking the image into tiles that are efficient for online viewing. This tutorial, however, provides methods for manually programming panning and zooming, perhaps best suited to maps with unique, custom designs and interactivity that would be compromised by the constraints of other options. The code provided is meant to facilitate adding panning and zooming to an independent map, requiring little or no modification to the map itself; this approach allows the map to be freely designed and built around its core information and functions rather than the supporting panning and zooming functions. Nonetheless, while a manual method of implementing panning and zooming allows more freedom, the cartographer should bear in mind that not every map may be worth the additional labor and time required.

The tutorial presents code and instructions for implementing panning and zooming using the Adobe Flash platform, following the precedent of Roth and Ross (2009) in the first digital issue of *Cartographic Perspectives*. Flash affords extensive freedom of both design and interactivity and thus serves interactive cartography very well. It is also currently pervasive on the web both in terms of content and browser support, and although its support is limited on mobile devices, it remains a safe choice of platform for publishing interactive maps intended for desktop or laptop use. The source files for this tutorial are exclusively ActionScript 3, the scripting language for Flash, and they do not require the use of one particular development environment. However, the step-by-step instructions are given only for Adobe Flash CS4 (CS3 is also compatible). Other options include Adobe Flash Builder (formerly named Flex Builder) or a free Flex SDK available at <http://opensource.adobe.com/wiki/display/flexsdk/downloads>.

The following instructions assume basic familiarity with Flash and ActionScript 3 concepts. For introductory resources and to download a trial version of Flash CS4, visit: <http://www.adobe.com/devnet/flash/>.

DECIDING HOW
TO IMPLEMENT
PANNING AND
ZOOMING
DEPENDS HEAVILY
ON THE DESIGN
AND PURPOSE OF
THE MAP

DOWNLOAD THE SOURCE FILES

The first step is to download the source files referenced in the tutorial. The code library for this tutorial is available at:

http://www.nacis.org/CP/CP66/pan_zoom_tutorial.zip

Download and extract the zip file to a folder of your choice. If you examine the extracted files, you should see two files and an **org** folder. Inside the **org/nacis/mapbrowsing** folder are the three main ActionScript classes that control panning and zooming:

1. **PanZoomMap.as**: The main class that creates a map that can be panned and zoomed.
2. **ZoomControls.as**: A set of three simple buttons to control zooming. The primary purpose of this class in the tutorial is to demonstrate how to create controls that interact with the map.
3. **NavigatorWindow.as**: A class that generates a navigator window (i.e., a small interactive overview map) for more advanced control of the panning and zooming methods in **PanZoomMap.as**.

PanZoomTest.fla and **PanZoomTest.as** are Flash project files used for demonstration in this tutorial.

OPEN THE FLASH PROJECT

Begin by opening the FLA file, **PanZoomTest.fla**. This is the main Flash document that contains graphics, code, and other settings. This project file will be used to create a simple panning and zooming interface for an example map. Upon opening the file, you will notice a blank stage and one Movie Clip called `ExampleMap` in the Library panel (Figure 1). Double-click `ExampleMap` to view it; it is simply a vector graphics drawing (Figure 2). This will serve as the source map that will be panned and scaled. A custom map could be inserted here, either by pasting graphics from another program or by drawing directly in the Flash environment, to replace the tutorial example. The map does not need to be a static image; it can contain interactive Flash components or more advanced scripted interactivity.

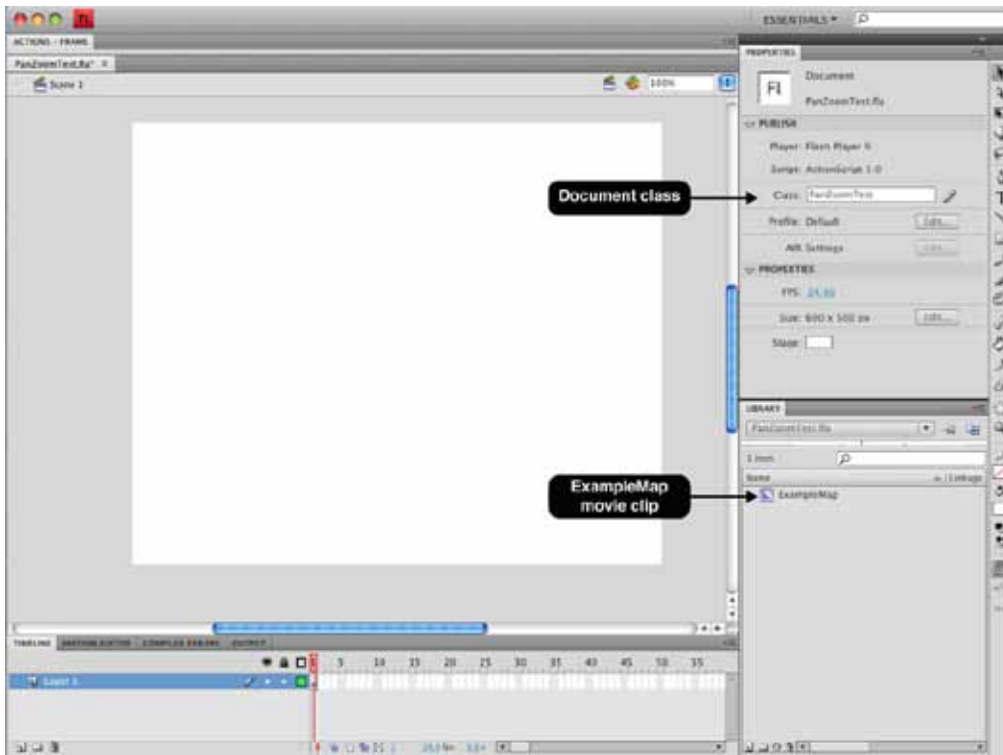


Figure 1. PanZoomMap.fla upon first opening the file. ExampleMap is listed in the Library panel on the right side.

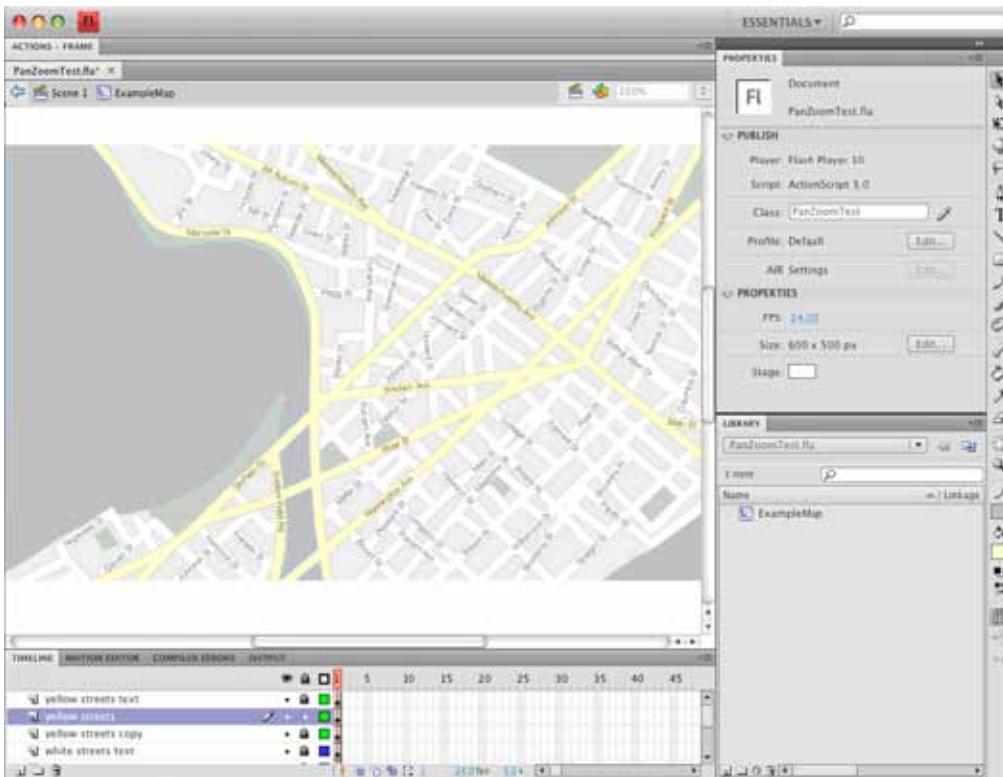


Figure 2. PanZoomTest.fla with the ExampleMap visible.

PREPARE THE SOURCE MAP

Rather than adding the map to the stage here in the authoring mode, it is more efficient to create the `PanZoomMap` instance and add it to the stage using only ActionScript. To do this, the `ExampleMap` library symbol must be exported for use in ActionScript. Right-click `ExampleMap` in the Library panel, select Properties, and check the “Export for ActionScript” box (Figure 3). If you do not see the options shown in Figure 3, click the “Advanced” button in the properties dialog. Note that the Class and Base class text fields become populated when “Export for ActionScript” is selected. `ExampleMap` will become an ActionScript class name that can be used to create a new instance (or multiple instances) of this source map. Both of these can refer to custom classes for advanced control and interactivity of the map, but for the purposes of this tutorial the map will remain simply a set of graphics, so leave the defaults as they are. Click OK on the Properties dialog and OK again on the warning message that appears. Save the FLA file.

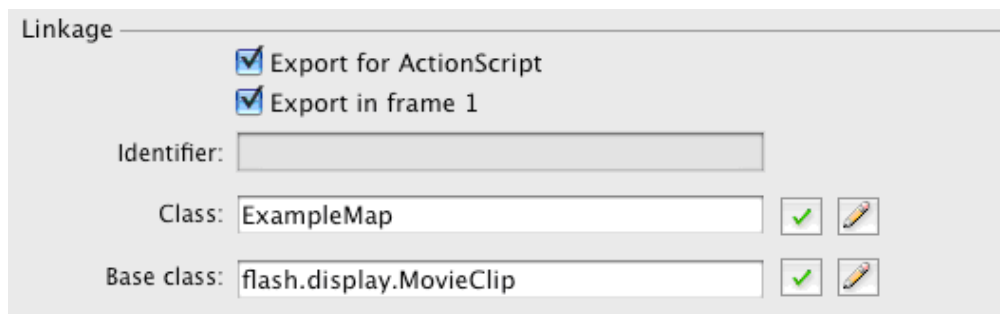


Figure 3. Exporting the movie clip for ActionScript

OPEN THE DOCUMENT CLASS

The FLA file is now ready to have code attached to it. ActionScript code can be written for the main Flash movie either directly on timeline frames or in a separate document class held in an ActionScript (.as) file. Because it keeps most of the code in a central, well-organized file, a document class is the better choice for projects relying mostly on ActionScript code, such as this tutorial. Click a blank area of the stage to clear any selection, and note that `PanZoomTest` has been defined as the document class in the Properties panel (see Figure 1). Open the class either by clicking the pencil icon next to that name or by directly opening **PanZoomTest.as** from the tutorial files.

CREATE THE MAP INSTANCE

Find the `// Declare variables here` comment in **PanZoomTest.as**. In this spot, instances of `ExampleMap` and the `PanZoomMap` will be created. To do so, insert two lines of code as shown below.

```
// Declare variables here
private var sourceMap : ExampleMap = new ExampleMap();
private var panZoomMap : PanZoomMap = new PanZoomMap( sourceMap, 500, 310 );
```

The first variable is an instance of `ExampleMap`, being used as our source map for panning and zooming. The second variable is an instance of `PanZoomMap`, placing the source map into a layout that can be panned and zoomed. A new instance of `PanZoomMap` requires three arguments:

1. A reference to the source map. This can be any display object. In this case it is `sourceMap`, the instance of `ExampleMap` created in the previous line.
2. The desired width of the viewable map area on the stage—the “window” through which the map will be viewed. This can be any number. 500 is arbitrarily chosen here.
3. The height of the viewable area. 310 is a height that approximately maintains the original aspect ratio of the source map in this case.

ADD THE MAP ON STAGE

Now find the `// Begin code here` comment in the `PanZoomMap()` constructor function. This code will run as soon as the SWF loads, so it is where the map will actually be added to the stage. The code below adds the `PanZoomMap` instance to the display and positions it a short distance from the top and left edges of the stage.

```
// Begin code here
addChild( panZoomMap );
panZoomMap.x = panZoomMap.y = 15;
```

Save `PanZoomMap.as` now and test `PanZoomMap.fla` by pressing Control-Enter (Windows) or Command-Enter (Mac). The SWF will be created and you should see the source map on the stage, scaled down to fit the specified 500x310 dimensions. By default, `PanZoomMap` establishes a minimum scale equal to the scale required to fit the entire map in the viewable area, and it zooms to that scale at the start. Notice that clicking and dragging the map has no effect. `PanZoomMap` also limits panning so that the left edge of the map cannot be dragged inward past the left edge of the viewable area, and so on. At the minimum scale, this means that no panning at all is possible. To be able to pan, you need to zoom in.

TEST ZOOMING AND PANNING

First, try zooming in and panning explicitly with code. Zooming is accomplished with `PanZoomMap`'s `zoomTo()`, `zoomIn()`, or `zoomOut()` methods, either by calling the functions directly or attaching

them to interface controls. The latter two methods increase and decrease the scale of the map by a factor of two. `zoomTo()` allows you to specify an exact scale, where 1 is the scale at which the source map is its original size. To get the current scale of the map, use the `zoomAmount` property. For a simple test, return to where you left off in **PanZoomTest.as** and add the following line of code to immediately zoom in by a factor of two:

```
panZoomMap.zoomTo( panZoomMap.zoomAmount * 2 );
```

Save and then run the SWF again, and the map will be zoomed in twice as far as before. Now you are able to pan the map by clicking and dragging. The panning is constrained in the manner described above. Similar to the `zoomTo()` method, there is also a `panTo()` method for jumping directly to a point on the map. Pass the `panTo()` method a `Point` object containing x and y coordinates in the coordinate space of the source map (in the case of the `ExampleMap` movie clip, the map's coordinates have their origin at the top left corner and extend to approximately 751 and 456 on the x and y axes, respectively). Insert the code below, save the file, and run the SWF. The map will be centered on a different area.

```
panZoomMap.panTo( new Point( 500,300 ) );
```

ADD USER CONTROL

The above example shows how to change the zoom level to a predetermined value through ActionScript code. Users, however, need to be given control over this value so that they can manipulate the zoom level to meet their own map use needs. Usually this involves creating buttons that invoke the `PanZoomMap` methods. **ZoomControls.as** is provided as an example set of buttons for controlling the map zoom. In **PanZoomTest.as**, erase or comment out the `zoomTo` and `panTo` lines to restore the map to the default behavior. Declare a new instance of `ZoomControls` and then add it to the stage and reposition it, as in lines 15 and 24–26 below.

```
1      package
2      {
3
4      import flash.display.MovieClip;
5      import flash.geom.Point;
6      import org.nacis.mapbrowsing.*;
7
8      public class PanZoomTest extends MovieClip
9      {
10
11         // Declare variables here
12         private var sourceMap : ExampleMap = new ExampleMap();
```



```

13 private var panZoomMap : PanZoomMap = new PanZoomMap( sourceMap, 500, 310 );
14 // Declaring a new instance of zoom controls
15 private var zoomControls : ZoomControls = new ZoomControls( panZoomMap );
16
17 public function PanZoomTest()
18 {
19
20     // Begin code here
21     addChild( panZoomMap );
22     panZoomMap.x = panZoomMap.y = 15;
23
24     addChild( zoomControls );
25     zoomControls.x = 15;
26     zoomControls.y = 330;
27 }
28 }
29 }

```

CodeBank 1. PanZoomTest.as with a map instance and zoom controls

When the `ZoomControls` instance is declared in line 14, it must be passed a reference to the `PanZoomMap` that it controls. You can examine `ZoomControls.as` to see how it uses the zooming functions on `PanZoomMap`, or to customize the design and placement of the buttons. When you run the SWF, there will be three simple buttons below the map. The “+” and “-” buttons zoom the map in and out, multiplying and dividing the map scale by two. The third button enables a zoom box mode. In this mode, click-and-drag panning is disabled and the mouse cursor becomes a tool for specifying an area to which to zoom. Click and drag on the map to draw a box, and when the mouse is released, the map will zoom to fit the area within the box.

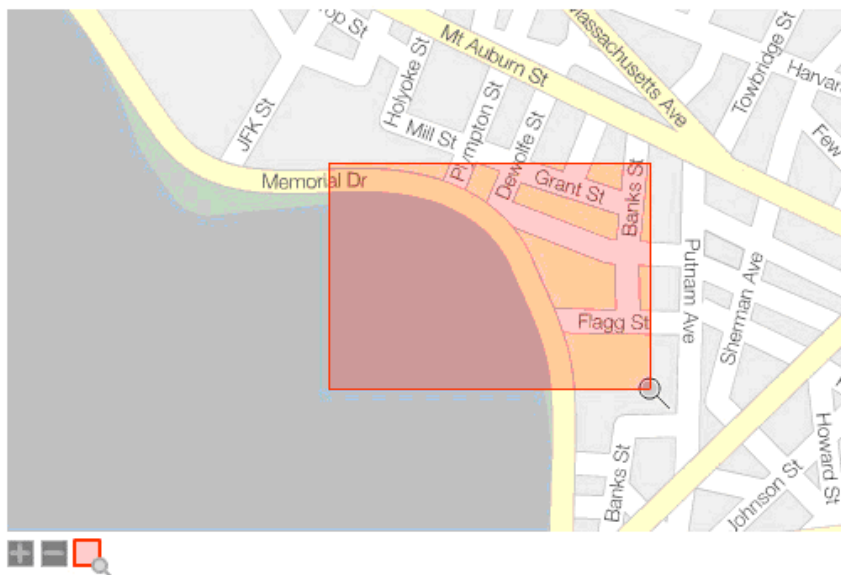


Figure 4. Zooming using the zoom box mode

PanZoomMap contains a zoomBoxMode property that enables or disables this mode. It is disabled by default. Clicking the zoom box button in ZoomControls simply toggles the property. The zoom box works by drawing a box on stage in the global coordinate space, transforming its dimensions and center to map coordinates using the globalToLocal() method, and then calling the zoomTo() and panTo() methods to rescale and recenter the map. Figure 4 illustrates the click and drag zooming implemented by the ZoomControls instance.

ADD A NAVIGATOR WINDOW

A final, more advanced control provided here is the NavigatorWindow class, which creates a small overview map that can be used to see the currently visible map area in context and also to pan the map quickly. Adding a navigator window is accomplished in the same way as adding the zoom control buttons. Create a NavigatorWindow instance, giving it a reference to the PanZoomMap instance and optionally a desired size expressed as a proportion of the full source map size (it defaults to 0.25 if no value is specified), and then add it to the stage (lines 15 and 28–30 below). The final code for this tutorial should look as follows:

```
1  package
2  {
3
4  import flash.display.MovieClip;
5  import flash.geom.Point;
6  import org.nacis.mapbrowsing.*;
7
8  public class PanZoomTest extends MovieClip
9  {
10
11     // Declare variables here
12     private var sourceMap : ExampleMap = new ExampleMap();
13     private var panZoomMap : PanZoomMap = new PanZoomMap( sourceMap, 500, 310 );
14     private var zoomControls : ZoomControls = new ZoomControls( panZoomMap );
15     private var navWindow : NavigatorWindow = new NavigatorWindow( panZoomMap );
16
17     public function PanZoomTest()
18     {
19
20         // Begin code here
21         addChild( panZoomMap );
22         panZoomMap.x = panZoomMap.y = 15;
23
24         zoomControls.x = 15;
25         zoomControls.y = 330;
26         addChild( zoomControls );
27
```

```

28     navWindow.x = 365;
29     navWindow.y = 330;
30     addChild( navWindow );
31     }
32 }
33 }

```

CodeBank 2. PanZoomTest.as with a map instance, zoom controls, and a navigator window.

Run the SWF again to test the navigator window. A red box on the overview map shows the area currently in view, and the box can be dragged to pan the map when possible (you will need to zoom in first). In simplified terms, the indicator box on the NavigatorWindow is drawn at the dimensions of the PanZoomMap's viewable area and scaled to the inverse of the PanZoomMap's zoom level. It is positioned easily—and also allows easy panning—because the coordinates on the NavigatorWindow correspond directly to coordinates on the PanZoomMap source map.

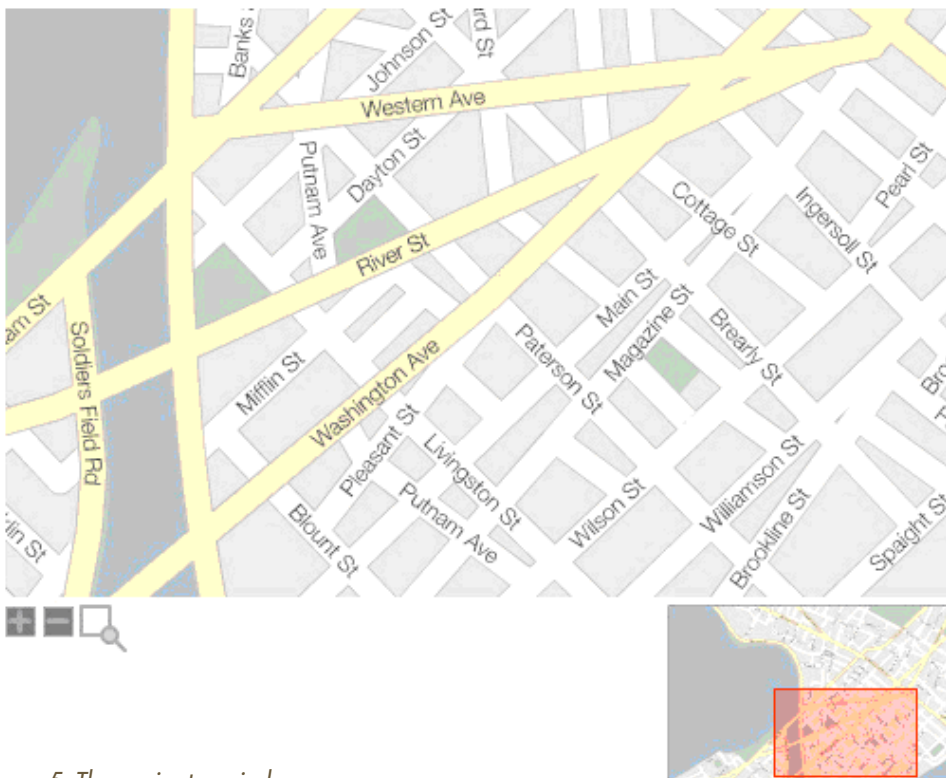


Figure 5. The navigator window

EXTENDING THE PANNING AND ZOOMING FUNCTIONALITY

This tutorial has covered the steps necessary to implement simple panning and zooming using the accompanying code base. Although only a handful of the code's methods specifically have been addressed here, the tutorial is intended to provide a basis for more complex and customized mapping by explaining a few key points. As the tutorial demonstrates, the provided ActionScript classes allow the generation of panning and zooming with only a few lines of code. The classes themselves are written with the expectation of further scrutiny from expert users, who can modify and extend the classes to suit their specific needs. To that end, the files contain explanatory comments within the code in an attempt to be as clear as possible about what exactly is happening in each section of code.

Although the tutorial is written for Flash CS4, the ActionScript classes in the **org/nacis/mapbrowsing** folder have no dependency on any single development environment, and can easily be used in Flex or pure ActionScript projects with Adobe Flex Builder or plain text compiled by an open-source compiler. Additionally, much of the code exhibits general concepts that can serve as a reference for writing the same functionality in other programming languages.

It is my hope that this tutorial, along with recent articles such as those by Roth and Ross (2009) and Peterson (2008), can help establish the new digital *Cartographic Perspectives* as a trusted distributor of programming-based web cartography resources, for the benefit of experienced and novice cartographers alike. With open community contributions, discussion, and updates such a repository can become more than a one-way broadcast of articles, allowing community members to build upon work like this tutorial and share those efforts.

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of opportunities offers great challenges and rewards to effective mobile application design and development (Kangas and Kinnunen 2005). Beginning such design and development from scratch, however, can be a time-consuming and tedious task. To streamline design, many smartphone application developers follow a process similar to creating mashups on the Internet. Google Maps is widely used for web-based maps, as the *Application Programming Interface* (API) is available for extension. In many cases, point locations are added to the Google Maps basemap (Miller 2006). With more advanced programming, other cartographic researchers have implemented choropleth maps (Peterson 2008) and animated mashups (Roth and Ross 2009) using the Google Maps API.

Similar mapping mashups can be created for smartphones. In this article, we describe how simple mapping applications can be created or modified for the Apple iPhone. We chose the iPhone because it leads the smartphone market in number of applications and because of its ease of distribution via the Apple App Store. Apple also offers a development environment that is available free of charge. A simple iPhone application plots the user's current location on a Google Maps basemap. More interesting applications, however, plot point locations from web databases. As an example, the Mailbox Find app, created by ObjectGraph (<http://www.objectgraph.com/>) and available in the Apple iTunes Store, displays all mailboxes in the United States in proximity to the user. The 8.6 Mb of information, consisting of 178,315 points, included in the database is downloaded and stored locally on the iPhone.

To help developers get started in accessing locations from databases, ObjectGraph (the application development company for which the first author is a founder) has launched a project called *GeoGears*, an open-source, map-based iPhone app project. The goals of GeoGears are twofold. One is to serve as a generic application into which users without programming knowledge can add their customized geographic locations. The second, not explored in this introductory article, is to provide an open source project that can be customized by programmers.

This document is designed as a tutorial for the non-programmer to begin to create or modify iPhone/iPod Touch/iPad applications (*apps*) that include a Google Maps basemap. After listing requirements and options, the first section guides the novice through the processes of installing the iPhone *Software Development Kit* (SDK) and building a simple application with basic Google Maps functionality from scratch. The second section shows potential uses for GeoGears and how to access a project prototype. This template allows users to integrate quickly their own geospatial point data into an app without any programming knowledge. Instructions show users how to substitute the provided sample data with their own delimited text data to create a customized map.

TO HELP DEVELOPERS
GET STARTED
IN ACCESSING
LOCATIONS FROM
DATABASES,
OBJECTGRAPH
HAS LAUNCHED A
PROJECT CALLED
GEOGEARS, AN
OPEN-SOURCE, MAP-
BASED IPHONE APP
PROJECT

REQUIREMENTS AND OPTIONS

Listed below are the requirements and options needed to create iPhone apps with this tutorial.

REQUIREMENTS

- Mac Laptop or Mac Desktop (a recent Intel-based CPU machine)
- Leopard (10.5) or higher MacOS
- 3GB space on the hard drive
- Apple Developer's account
- The latest iPhone SDK with XCode
- Ability to modify SQLite database (the latest FireFox Internet browser & SQLite Manager add-on)

OPTIONS

- iPhone or iPod Touch device with OS 3.0 or higher
- Geospatial data in a spreadsheet or delimited text format
- \$99 for iPhone Developer License Fee

BUILDING A SIMPLE APP FROM SCRATCH

OVERVIEW

With the first five required resources listed above, this section provides step-by-step instructions for creating a simple app from scratch that plots the user's current location atop the Google Maps basemap.

SET UP A MACHINE

Your Mac should be running the Leopard or higher operating system (OS). To check your OS version, Go to the **Apple icon** in the **Menu** and click **About This Mac**. Confirm that the Mac OS X version is 10.5.8 or higher and that it utilizes an Intel processor.

If your Mac is not running a current version of the OS, click on the **Software Update** button. Check all items in the pop-up window and then click the **Install** button.

SET UP A DEVELOPER'S ACCOUNT

The next step is to set up an Apple developer's account so that you can download the iPhone SDK, both of which are free of charge. Open an Internet browser and go to the following URL: <http://developer.apple.com/iphone/>

Click the **Register** link and create your developer's account. If you already have an account with Apple, you can choose to use this information instead of creating a new account.

SET UP XCODE AND IPHONE SDK

Once you log into the *Apple Dev Center* with your user ID and password, click the **Downloads** link and download the *iPhone SDK*. Be sure to select the version that is compatible with the version of the OS you identified in the earlier step. If your MacOS is version 10.5.x, you are running Leopard; if it is version 10.6.x, you are running Snow Leopard.

Download the file on your desktop and, once the download is complete, follow the installation wizard. Install the software using the default settings. As this file is large (more than 2 GB), this process may take some time. Once installed, the application can be found under **Machintosh HD > Developer > Applications**. Double click on **Xcode.app** to start the application. You may want to create a shortcut to this application by dragging and dropping it to your desktop or your dock.

XCode is a software program used to edit program source codes and resources. It helps you to develop software for the Mac or the iPhone. iPhone SDK is an additional package of components that is necessary for iPhone development. The SDK includes a simulator to test iPhone apps on a Mac within a window that resembles an iPhone, allowing developers to see how the application will appear on an iPhone without having to load the app onto the physical device. Apple developed a high-level API called Cocoa, which is used on Mac OS X to construct the *Graphic User Interface* (GUI). Since the iPhone OS is one of a family of Mac OS, Apple integrated Cocoa into iPhone OS, calling it *Cocoa Touch*. As you can imagine from the name, it handles users' behavior on the iPhone based on Apple's touch screen technology. Cocoa Touch is tightly integrated into the SDK and XCode so that developers can handle complicated user touch actions (e.g., pinch), as standardized by Apple. *Interface Builder* (IB) is another important component of the SDK that integrates Cocoa Touch technology on XCode. The IB is designed so that each layout of an iPhone display can be modified. Simple modifications do not require programming knowledge; components simply can be added and positioned by dragging, dropping, and resizing them in the application.

CREATE A SIMPLE MAPPING APP

Open XCode and Create a Cocoa Application using the following steps:

1. Select **File > New Project** and choose **iPhone OS > Application** on the left selection menu.
2. Click **View-based Application** as your template and click the **Choose** button in the lower right corner.
3. Enter “MyMapApp” as the project name and click **Save**.
4. Now that this project is saved, if you quit XCode you can reopen the project by going to the “MyMapApp” folder and double clicking on the file “MyMapApp.xcodeproj.”

You can see that some other files have been generated when completing these steps. You can browse these by looking under **Groups & Files** in the selection menu on the left (Figure 1). Files are organized under “MyMapApp” in various folders. You are now ready to add the MapKit framework to your project. This framework will provide your application with a Google Maps basemap, as well as allow it to utilize locational information and features. Begin by expanding the **Targets** menu in the selection menu on the left. Double-click “MyMapApp” found beneath the **Targets**. This will open a new window with target information for this app.

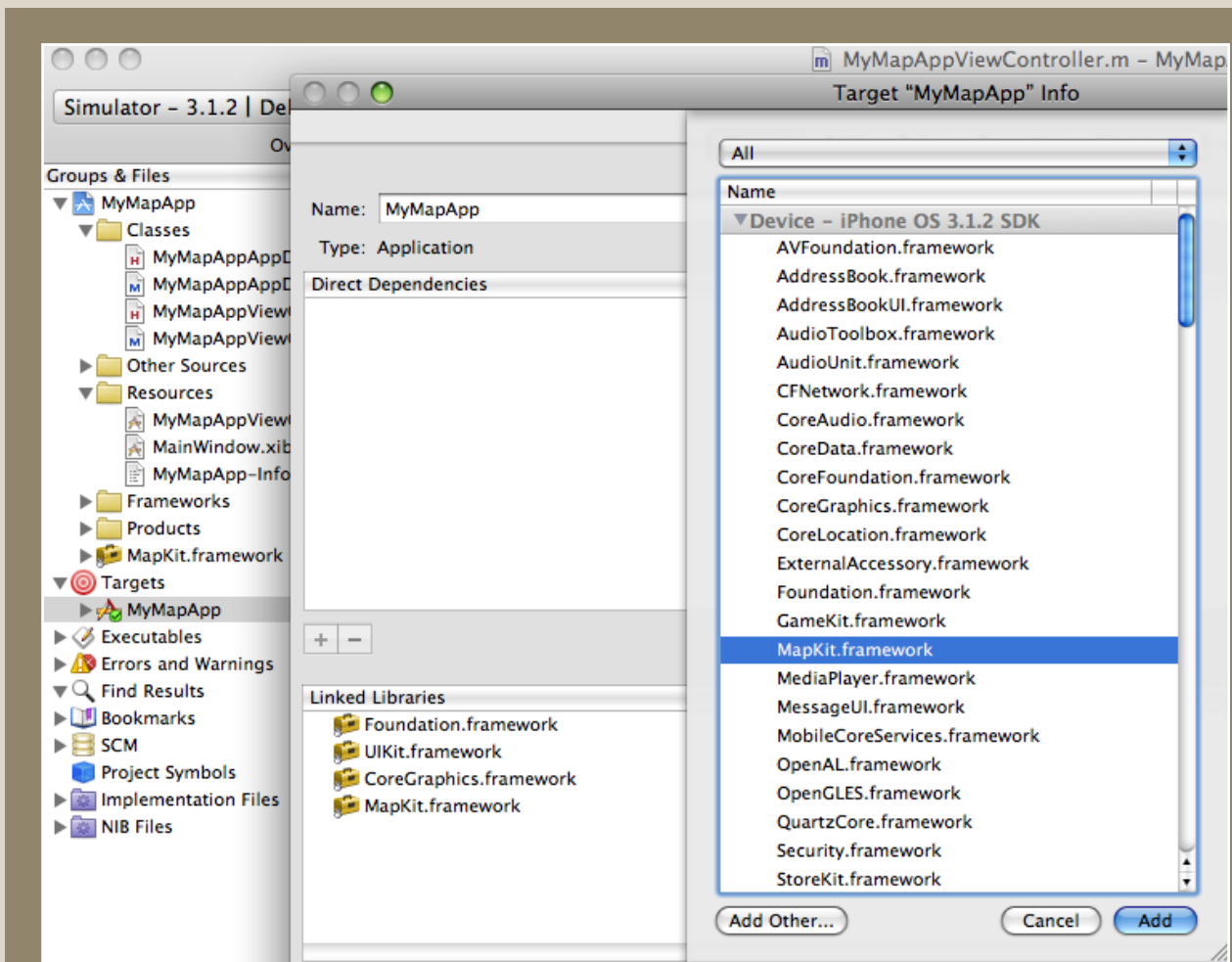


Figure 1. Three menus (see text for detail) which shows procedures to add MapKit framework into your map application.

Apple provides fundamental programming components, called frameworks (e.g., MediaPlayer, GameKit, and MapKit), to speed up the development process. Let's add the MapKit framework to our project. Click the + button in the lower left corner of this window. This provides a list of frameworks which can be incorporated into the app. Scroll down the list until you find the **MapKit.framework**, select it, and click the **Add** button. You should now see the **MapKit.framework** listed in your **Groups & Files** under "MyMapApp." This framework is now available for your developmental use.

You can add a **MapView** in your app with IB. To add the **MapView**, expand the **Resources** folder and double click "MyMapAppViewController.xib." The extension .xib indicates that this is a layout file.

The IB will open additional windows for your use. This tutorial will refer to four of these windows. It is possible, however, that some of these windows may not be visible to you upon first opening the IB. To ensure that all of the necessary windows are visible, look under the **Tools** menu and activate **Library** and **Inspector**. If **Tools > Reveal In Document Window** menu item is available, select it as well. Then double click **View** icon.

If at any point you are unable to find one of these windows, use the **Tools** menu and the instructions above to make the windows visible once again. At this point, you should be able to view all of the windows shown below in Figure 2.

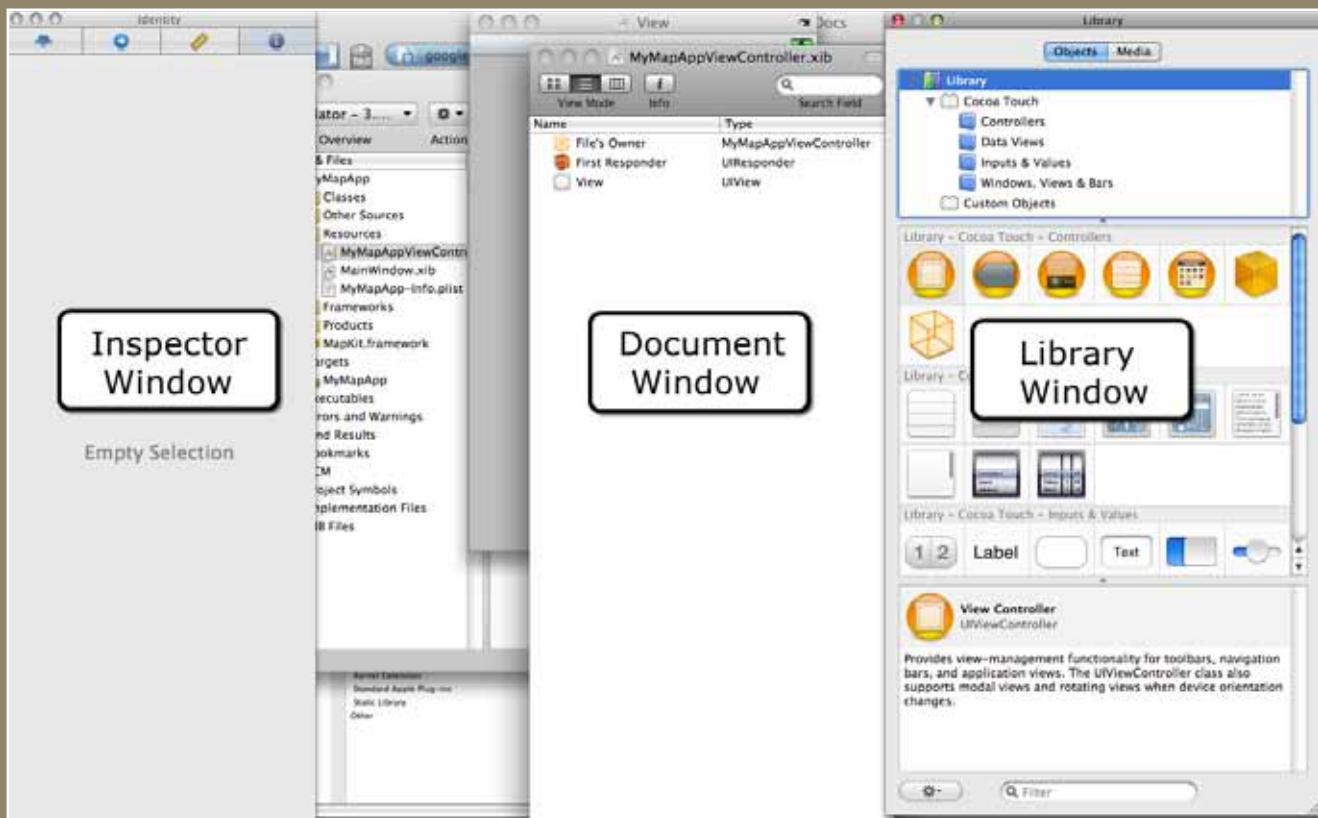


Figure 2. The three windows of Interface Builder (IB).

In the **Library** window (Figure 3), scroll down your list of objects until you see an icon for **Map View**. This is the data view that will allow you to add the Google Maps basemap and basic functionality to your app. Google provides the map data via a network connection and it downloads the images to render them on the screen. In addition, users are able to navigate the map with a multi-touch user interface, such as pinching to zoom in or out and swiping to pan. Drag and drop the **Map View** icon into **View** window. If you do not see the **View** window, go to the **top menu > Tools > Reveal in Document Window > double-click View**.

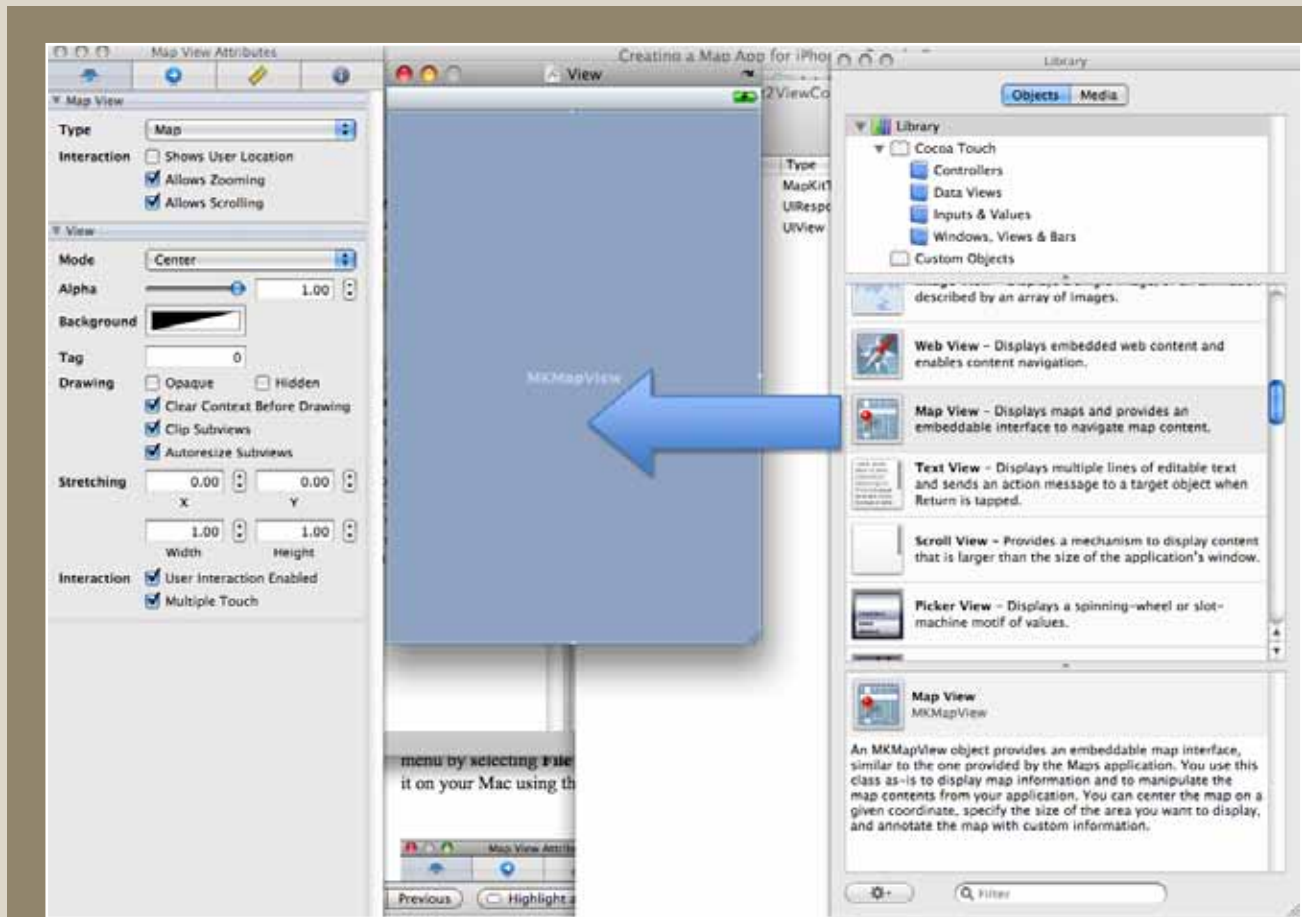


Figure 3. Adding the Map View control to the MyMapApp layout.

There is some limited functionality you can set for the map view in your app by selecting or deselecting different options. In this example, we assume you will want your app to display the current location of the user. To include this functionality, go to the **Inspector** window and click the leftmost tab. You can see the other available functions include zooming and scrolling (i.e., panning) of the map display. Check **Shows User Location** (Figure 4) and save your changes from the top menu by selecting **File > Save**. You are now ready to build your first iPhone app and demonstrate it on your Mac using the Xcode simulator.

You may keep the IB windows open, but go back to XCode window. The **Targets** should still be set to MyMapApp. Click **Build and Go** at the top center of the XCode window.

This will build your app and initiate the simulator, which looks like an iPhone displayed on your Mac (Figure 5). If successful (it may take a minute to build and initiate), you should see the simulator window with a map and a blue dot as shown below. The blue dot is supposed to indicate your current position, but for apps running on the simulator the default location is Apple's headquarters in California. If you were to deploy your app on an iPhone, it would display your current location, using coordinates from the global positioning system (GPS) built into the iPhone.

Click and drag to scroll around the map display. Double-click to zoom in on a map location and single click (with two fingers) while holding option key to zoom out. Alternatively, you can simulate the "pinch" techniques used for maps on multi-touch devices such as the iPhone to zoom in and out. While running the simulator, hold down the option key while using a finger and thumb to pinch in or out on the touchpad. Gray circles on the map display approximate your pinching motion.

To exit this screen, press the home button at the bottom center of the simulation.

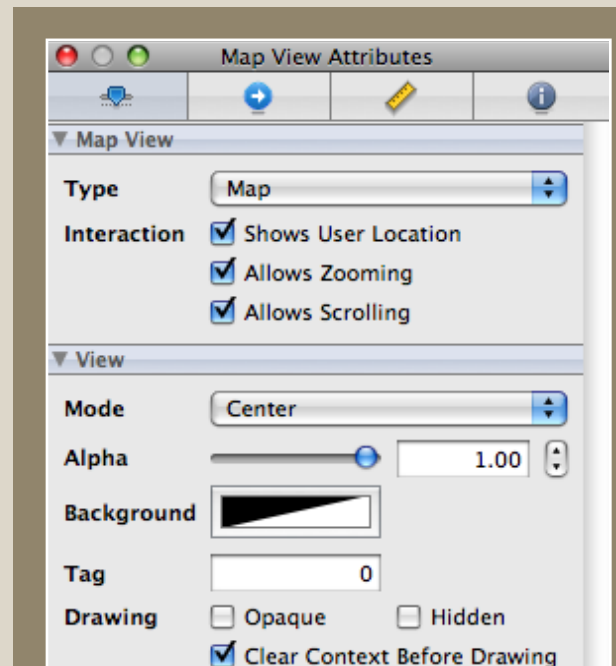


Figure 4. Options for types of interactions with the map, including an option that allows the user's location to be displayed in the MyMapApp.

CUSTOMIZING THE GEOGEARS PROTOTYPE APP

OVERVIEW

GeoGears is a prototype app that accesses spatial data from a database and plots the data on a map. It maps this data on the MapKit basemap, discussed in the previous section. It also has additional functionality built into it, such as options for mapping one of a selection of databases and an option for searching within the databases. This section discusses how to download and open the GeoGears project on a Mac, which will display sample points around the default location. Users are then instructed how to download and install a Firefox plug-in called SQLite to edit the dataset of sample points. Users are guided through steps for editing one record in the database representing one point, and then through steps for copying and pasting their own delimited text data into an empty database for creating custom maps.

DOWNLOAD GEOGEARS PROJECT

Download GeoGears from the following URL: <http://www.geogearsapp.com/download/>.



Figure 5. The simulator window.

Click on the “GeoGears XCode Project (The Latest Version)” link. After downloading, double click the file “GeoGears.zip” to uncompress the project into a GeoGears folder. In the GeoGears folder, double click the blue icon labeled “GeoGears.xcodeproj” and XCode will launch the project. To test the app, click the **Build and Go** icon referenced in the previous section of this tutorial. You should now see the project in the simulator.

In the search bar, you can enter an address that you would like to search (e.g, your zip code). The spatial search service is from the Google Maps geocoding service. Before proceeding to the next steps of modifying a sample database, press the **home** button and exit the simulator screen.

INSTALL SQLITE MANAGER ON FIREFOX

In this tutorial, you will be given instructions on how to modify a sample database using SQLite Manager, a plug-in for the Firefox web browser. If you do not have Firefox (or its latest version), go to <http://getfirefox.com/> and install the latest version of this web browser on your Mac. You can access the SQLite Manager download by first clicking on the **Add-ons** menu on the Firefox website and performing a search for “SQLite Manager.”

Find this add-on in the list and click **Add to Firefox** button. You also can find this plug-in at the following Google code website: <http://code.google.com/p/sqlite-manager/>. If Firefox blocks the popup menu required for installation, click the **Allow** button in the yellow dialog box. Then, click the **Install Now** button after the download is complete. The installation wizard will recommend that you restart Firefox installation; click the **Restart Firefox** button to do so. You are now ready to use SQLite Manager to modify the sample database.

MODIFY THE SAMPLE DATABASE

Begin by ensuring the sample database is present. Go to Finder and open GeoGears folder. Navigate to the **GeoGears > data > database > Sample** sub-folder. You should find two files here: “data.sqlite” and “info.html.” You will be opening and modifying the “data.sqlite” file. The “info.html” file contains information related to the database itself, including potential information on copyright or ownership. This information can be displayed on the detail page. To see the detail page, click on the **database** button in the lower right corner of the map in the simulator, then click on the blue and white arrow next to Sample listed under **Select database to use**.

Start the Firefox web browser and go to the top menu item **Tools > SQLite Manager**. Click the **Connect Database** icon, which is represented as an open yellow folder. Navigate to the sub-folder as instructed above (**GeoGears > data > database > Sample**) and select the file “data.sqlite.” From the left menu, expand **Tables (2)** and select the “locations” table. On the right hand side, click **Browse & Search** tab. The display of the database in SQLite Manager should look like the image shown in Figure 7.



Figure 6. GeoGears with sample data.

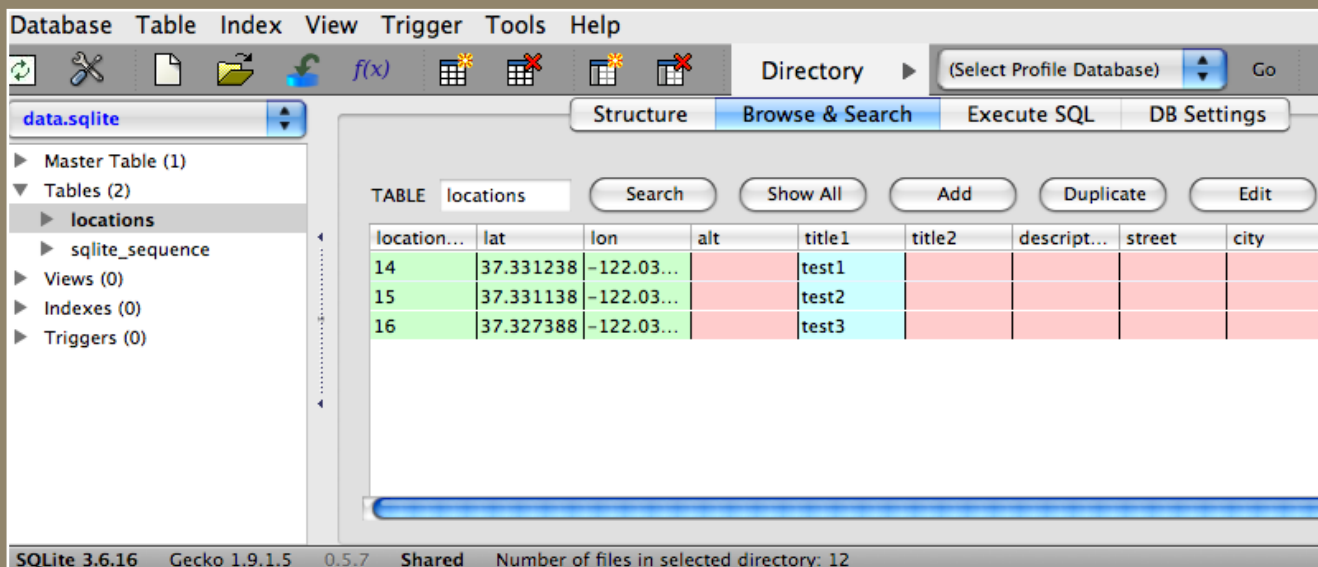


Figure 7. SQLite Manager editing screen.

You are now able to edit this database, and your edits will be displayed in the app simulator. Begin by double clicking the first row, which will open an editing screen. At this time, we will not change locations, but instead the attributes of one of the points. When these points are displayed on the map, a single click of a pin will show a display of **title1** and **title2**. Clicking on this title window will display a separate layout containing all of the other information in the database. Modify **title1**, **title2** and **description**. In the Figure 8 example, we enter **title1** as “My Pin,” **title2** as “Hello World,” and **description** as “This is my sample pin.”

In addition to textual information, you can also change a database value to modify the color of a pin. To change the color of the pin with **title1** equal to “My Pin” from red to green, change the value of **pin_type** to 2. Click **OK**, and you should see a message that the changes were made successfully. Your modified database display should now look similar to the image shown in Figure 8. After completing your edits, click **Cancel** to exit this display. If users have programming knowledge in Objective-C, they can make additional customizations to the color, symbol, etc.

PACKAGE AND INSTALL THE SAMPLE DATABASE

The GeoGears application requires that data is packaged (compressed) for efficient download. You thus are required to compress your “Sample” folder, which should now contain the modified “data.sqlite” file and the unmodified “info.html” file. Go to **Finder** and navigate to **GeoGears > data > database**. First, delete the old “Sample.zip” file, as you are creating a new one. Drag & drop “Sample.zip” from the “database” folder into the trash can. Select the “Sample” folder then right click (press the Control key and click) to display a pop-up menu. Select **Compress “Sample”** in the menu.

Your new package, “Sample.zip”, is now ready. Go back to the XCode window. From the top menu, select **Build > Clean All Targets** then click



Figure 8. A mapping app displaying customized points built with GeoGears.

Clean to confirm. This will ensure that the old database is gone and that it is prepared for a new one to be installed. Click the **Build and Go** icon and the simulator will open in a short time.

You should now see a map of the sample data with two red pins and one green pin. The green pin is the one representing the record in the database that you modified in the steps above. Zoom in by double clicking the map until you are able to click on the green pin. You now should see “My Pin” and “Hello World” displayed in the text fields title1 and title2, which you modified. Now click on the blue and white arrow associated with this text to see the remainder of the database. This should include any modifications you made in the previous steps.

POPULATE A DATABASE WITH CUSTOM DATA

In this section, we provide steps to import a text file in comma-separated value (csv) format into a database that can be mapped by the GeoGears application. You will accomplish this by cutting and pasting your custom data into a .csv file. After completing this process and converting your file into “.sqlite” format, you can package and install the new database in the GeoGears application, as described in the previous section.

We have provided a file called “locations.csv” which can be found in the **GeoGears > data > database folder**. Open this file with Microsoft Excel or another program that can edit comma delimited text files.

The file is empty except for the first row, which is composed of the header names for each column. These names should not be changed, and the format of data you copy into this file must be consistent with the data types of each column listed below:

- location_id - (Required) Leave this column blank.
- lat - (Required) Numeric in geographic decimal degree format.
- lon - (Required) Numeric in geographic decimal degree format.
- alt - (Optional) Numeric
- title1 - (Optional) Alpha Numeric. *Will appear when pin is clicked.*
- title2 - (Optional) Alpha Numeric. *Will appear when pin is clicked.*
- description - (Optional) Alpha Numeric. HTML format is available.
- street - (Optional) Alpha Numeric
- city - (Optional) Alpha Numeric
- state - (Optional) Alpha Numeric
- zip - (Optional) Alpha Numeric
- country - (Optional) Alpha Numeric
- pin_type - (Required) Numeric. Either 1 (red pin), 2(green pin) or 3(purple pin).

The first column, although required by the project, should be left blank so that GeoGears can assign a unique identifier to each record. You must copy in values of **lat** and **lon** in numeric geographic decimal degree format for pins to be placed properly on the basemap. As in the previous example, **title1**

and **title2** will appear when an individual pin is clicked. The remainder of the database will appear on a separate page when the blue and white arrows next to these titles are clicked.

You are now ready to convert the “.csv” file into a database in “.sqlite” format. Go to your Firefox web browser and access **Tools > SQLite Manager** from the top menu. Click the **Connect Database** icon (yellow open folder icon), as instructed previously, and reconnect to “data.sqlite.” Before importing your custom data, you should right-click on the “locations” table and then select **Empty Table**. This will ensure that the data from the Sample folder accessed previously has been removed. After clearing the old sample locations, go to the **Top Menu > Database > Import**. Click the **Select File** button and select the “locations.csv” file into which you have copied your data. Ensure that “locations” is in the text box under **Enter the name of the table in which data will be imported**. Check the **First row contains column names** option.

Click the **OK** button then click **OK** on the confirmation dialog box. You should see a message that the import was successful. Upon clicking the **Browse & Search** tab, you should see your imported data in the SQLite Manager. The “data.sqlite” file in the Sample folder has now been revised.

Now that your data is saved in an “.sqlite” format, GeoGears can use it to create a map. You first will need to delete the old “Sample.zip” file, package your data into a new “Sample.zip” file, and rebuild the application, as described in section 3.5. If your data is not near the default location in the simulator, type the location of your data into the search bar. You also may want to set the search radius to a larger value depending on the extent of your point data. To reset the search radius, click on the **Gear** icon in the lower right corner of the map in the simulator and set the **slider bar** for your desired search radius.

DEPLOY THE APP ON A DEVICE

If you have an iPhone, iPod Touch, and the \$99 developer’s license, you can deploy this app with your custom dataset on your personal device. The most notable difference in functionality is that now the blue dot representing the current location should indeed represent your present location instead of the Apple headquarters default location used by the simulator.

If you would like to submit your new app for approval by Apple, you may do so by following instructions documented at the iPhone Development Center (<http://developer.apple.com/iphone/>). Specific instructions can be found in the Program Portal User Guide at the **Program Portal** menu. Approved apps are distributed exclusively through Apple’s iTunes Store. In reality, most apps that are approved and frequently downloaded require significant amounts of customization beyond displaying a custom database on a Google Maps base.

CLOSING COMMENTS

The evolution of mobile mapping applications—such as smartphone applications in general and iPhone apps in particular—is likely to continue at a rapid pace. Those interested in developing such apps should consider opportunities that meet at the crossroads of two important considerations. The first consideration is how new technology can best be leveraged, the primary focus of this introductory tutorial. The second consideration is how mapping apps can best meet the geospatial needs of potential users, a critical and very open-ended question.

With tens of millions of individuals carrying smartphones, the market for useful applications that run on these devices is huge and is continuing to grow. Additionally, some distribution models for applications, like the Apple App Store, have built-in functionality for capturing user demand and feedback. In addition to documenting the number of downloads, users are encouraged to rate the app and supply feedback, which is often incorporated into future releases. This integrated system for acquiring valuable information on how users interact with maps should be of great interest to academic and professional cartographers.

A cartographer developing apps for the iPhone user is likely to want to customize numerous aspects of his or her maps. Such customizations are possible for mapping apps using the MapKit components. Our next tutorial will describe some examples of customization possible for experienced programmers, which are designed to begin making a mapping application easier to use and richer in functionality. Additionally, GeoGears is designed as an open source project which we hope programmers will find useful. For example, instead of conforming to the structure of the sample database presented in this tutorial, the code could be modified to conform to any user's database structure.

As a forum for further discussion, we have included the capacity to comment on this application on the GeoGears web page. Please feel free to leave comments or questions at: <http://www.geogearsapp.com/> (click the # **Comment(s)** link).

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WEB RESOURCES

- Firefox web browser: <http://getfirefox.com/>
- GeoGears Project Home: Instructions, Demo, Download and Blog: <http://geogears.objectgraph.com/>
- iPhone Development Center: <http://developer.apple.com/iphone/>
- SQLite Manager plug-in: <http://code.google.com/p/sqlite-manager/>

Student Web-Mapping Competition 2009

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Hewitt, TX 76643

INTRODUCTION

The thing that most surprised me when judging the student web-mapping competition was the diversity of the entries. Not only did we have maps sent from universities all over the country, but the students' subject matter, graphic presentation, and interactive techniques really showed the amazing variety that is possible in web maps. The two winners are both excellent examples of their respective categories and show great professionalism and polish, but every entry really opened my eyes to the excellent web-mapping work students are doing today. Although the 2011 NACIS conference may seem a long way off, teachers, please tell your students about this competition today! The maps they create in this current academic year are eligible for the upcoming competition, and we would love to see the great work they have been doing. For complete rules and submission guidelines, visit the web site: <http://www.nacis.org/index.cfm?x=4>



WINNER, INTERACTIVE

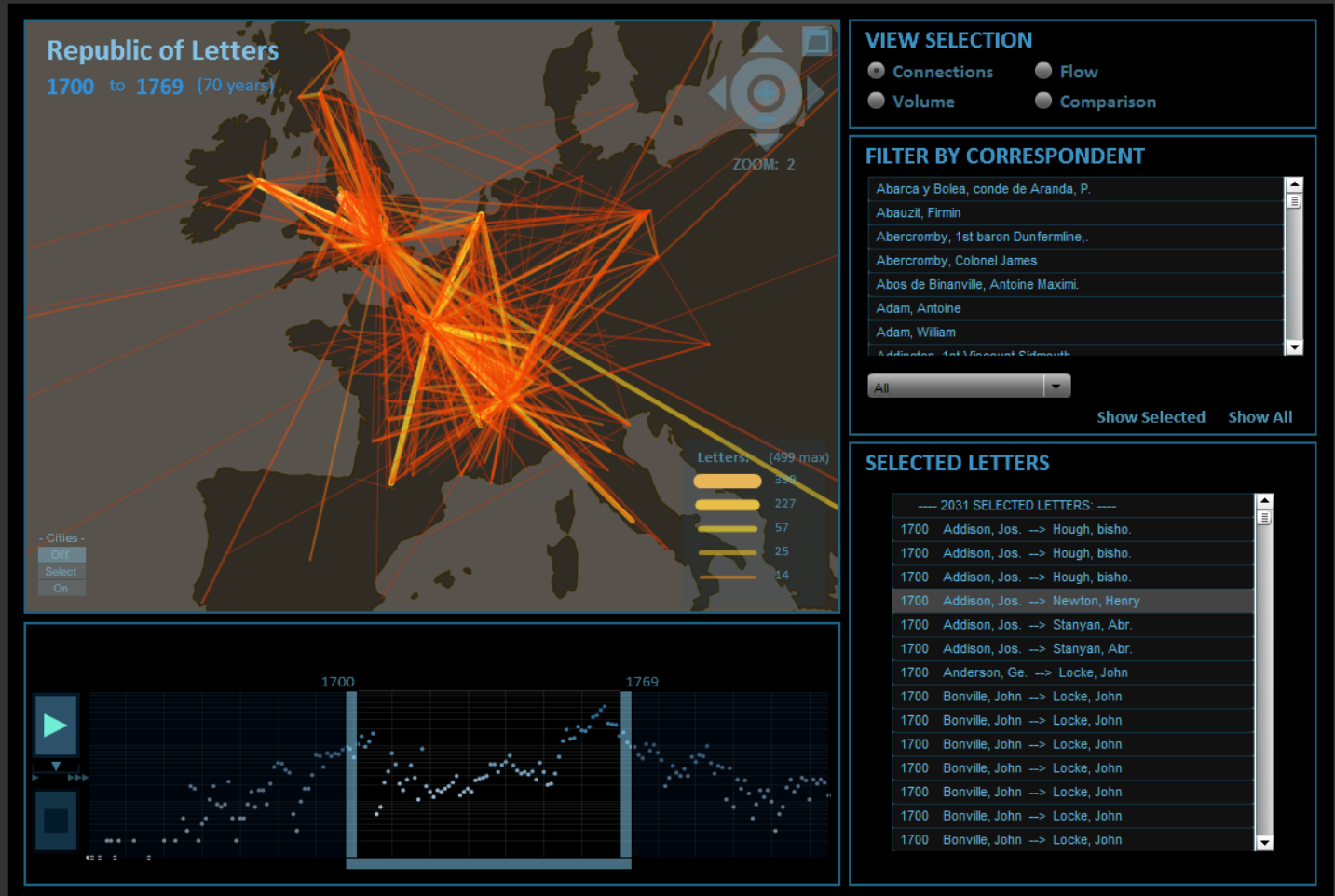
Yuankai Ge, Daniel Chang, and Shiwei Song, Stanford University
"Visualization of the Republic of Letters"
<http://stanford.edu/group/toolingup/rplviz/>
(Detail on following pages)



WINNER, ANIMATED

A.D. Riddle and David Parker, University of Wisconsin—Madison
"The Dead Sea: A History of Change"
<http://deadseachange.webs.com/map.html>
(Detail on following pages)

Visualization of Republic of Letters



* Hold "Shift" and use mouse to select letters on a line

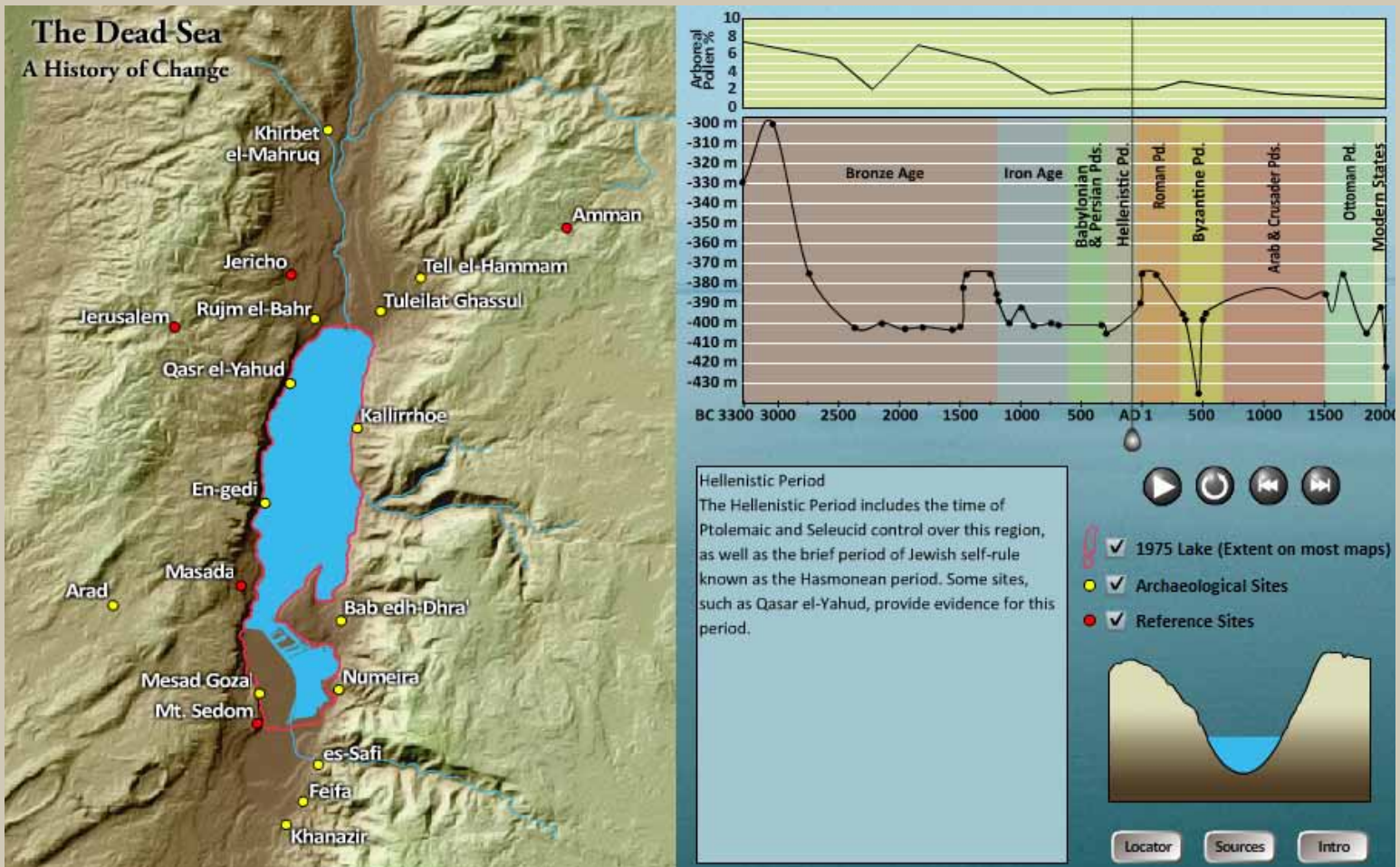
Introduction

Historians and other humanities scholars are increasingly seeking to develop and use visualization tools, methods, and theories for making sense of patterns in large sets of heterogeneous historical data with multiple dimensions. For example, the [Electronic Enlightenment database](#) of over 55,000 letters and documents exchanged between 6,400 correspondents in the Republic of Letters presents a typical challenge confronting the emerging field of digital humanities. How can humanities scholars trained in close reading of individual documents make sense of patterns in large sets of data?

VISUALIZATION OF THE REPUBLIC OF LETTERS

YUANKAI GE, DANIEL CHANG, AND SHIWEI SONG, STANFORD UNIVERSITY

The Republic of Letters is an intellectual network of over 55,000 scholarly letters between 6,400 correspondents during the Enlightenment period, and spans the years 1629 to 1824. Under the collaborative efforts of the Stanford Spatial History Lab and the Electronic Enlightenment database, we sought to visualize this giant corpus of data and explore how correspondences helped shape the European Enlightenment. The visualization as a tool provides historians with coarse- and fine-grain information filtering over space, time, and correspondents—down to the contents of each individual letter. Its primary goal is to enable historians to reveal insight and raise new questions about this crucial era in European history through visual representation of a historical database.



THE DEAD SEA: A HISTORY OF CHANGE

A.D. RIDDLE AND DAVID PARKER, UNIVERSITY OF WISCONSIN—MADISON

“The Dead Sea: A History of Change” is an interactive, animated map that displays estimated levels of the Dead Sea throughout the Late Holocene epoch, specifically from 3500 B.C. to the present. The map includes a timeline of archaeological periods with a graph showing the estimated lake level, a corresponding pollen graph, a cross-section of the Dead Sea depression, and selection boxes for displaying on the map site locations and the 1975 lake level (which is the level that appears on most maps). The user is able to investigate the map further by scrolling over sites on the map, the archaeological periods on the timeline, or the pollen graph, and context-appropriate information will appear in the text field.

The conclusions presented in this map are drawn principally from an AAG paper by Barry Beitzel and various publications of Amos Frumkin, supplemented by additional sources. The level of the lake for a given period is deduced from the following kinds of evidence (when present): arboreal pollen counts, flood sediments and Aragonite deposits in caves, aggradation of wadi floodplains, dendrochronology and radiometric dating of organic remains, textual references, and the location of archaeological sites. The map will be of interest primarily to those who study paleoclimatology, Middle East archaeology, and/or historical geography. It suggests certain conclusions regarding regional climate throughout the Late Holocene, as well as the possible locations of ancient land and nautical transportation routes for the historical periods.

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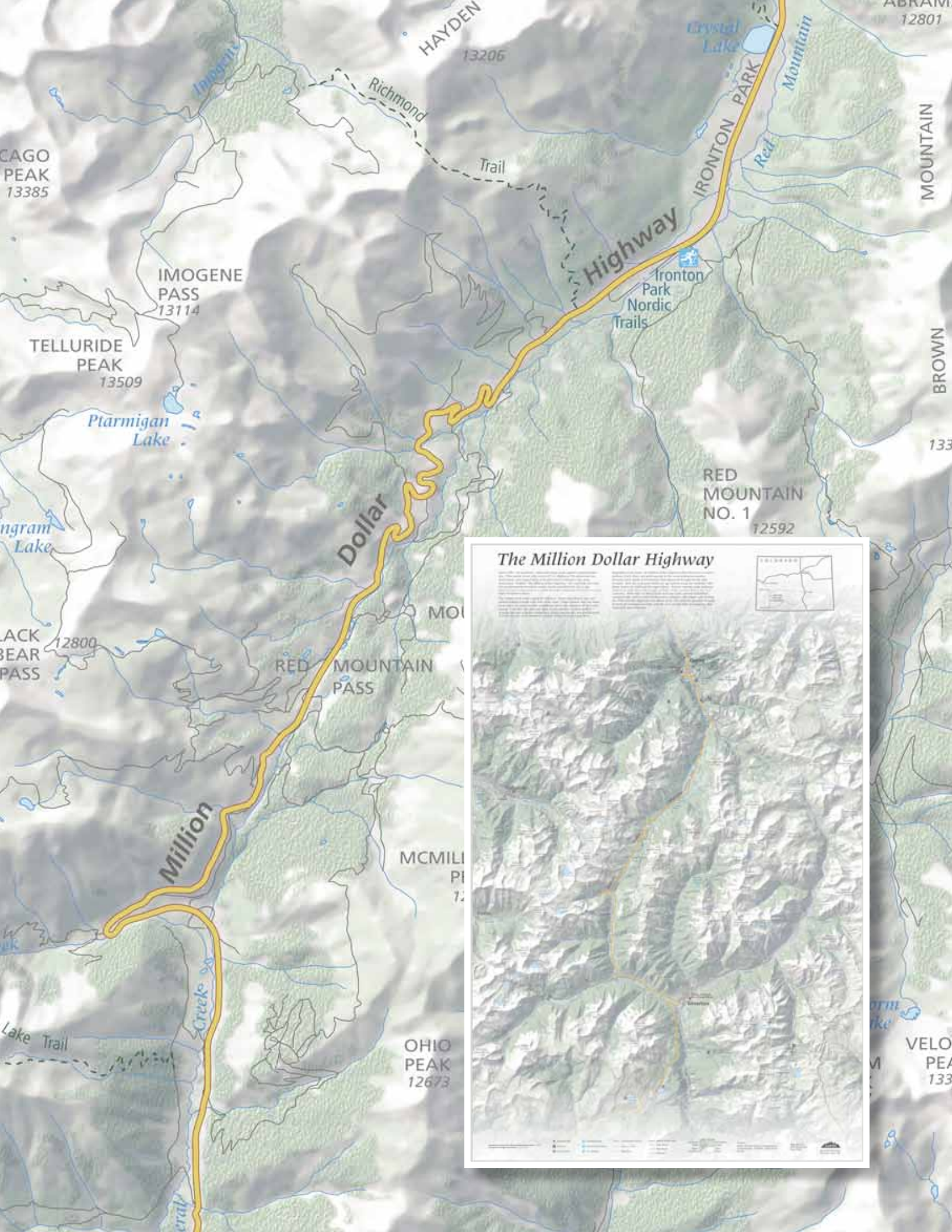
INTRODUCTION

The Student Poster Competition at the 2009 NACIS conference again provided students from throughout the nation with an interactive and social forum for displaying and discussing their work. Budding cartographers tell me it is a unique opportunity to showcase their efforts and get feedback from some of the best in the business. Poster viewers often cite this event as their favorite function at the conference, and feel a sincere commitment to offering suggestions and guidance to future mapmakers. As this issue of *CP* will be released after this year's deadline, I encourage all students to plan ahead for next year's competition and hope you will attend next year's annual meeting in Madison, Wisconsin! The deadline for entry will be mid-September. Competition rules and online registration form can be found on the NACIS Student Poster Competition page at <http://www.nacis.org/index.cfm?x=18>.

Winners are selected by balloting, with every attendee eligible to vote. The majority of the 2009 vote was captured last year by Mike Boruta of Ohio University for his poster "*The Million Dollar Highway*." Mike walked away with a check for \$500 for his cartographic endeavor. The next two most-voted-for posters were separated by only a few votes, underscoring how important everyone's vote is. Second place went to Diana Muncy of Humboldt State University for her poster "*Alaska: A Peak of Upheaval*," and Honorable Mention went to Daniel Huffman of the University of Wisconsin Cartography Lab for his entry, "*Visualizing Airfare*." Both students received a free one year membership in NACIS in recognition of their outstanding efforts.

(Detail on following page)





The Million Dollar Highway

(Detailed text describing the highway's history and scenic value, including information about its construction and the views it offers.)

(Detailed topographic map of the Million Dollar Highway route, showing elevation changes, road conditions, and scenic viewpoints.)

Legend:

- Road
- Trail
- Creek
- Lake
- Peak
- Pass
- Elevation

CP Peer-reviewed Student Paper Competition

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ANNOUNCEMENT

The North American Cartographic Information Society (NACIS) and *Cartographic Perspectives (CP)* is pleased to announce a **NEW** Peer-reviewed Student Paper Competition for 2011!

Any peer-reviewed manuscript accepted for publication in *CP* (2011 issues) whose first author is a student is automatically eligible. Student papers will be judged annually by members of the *CP* Editorial Board and the *CP* editor.

AWARD FOR WINNING ARTICLE:

\$1350

Details regarding eligibility and criteria for evaluation will follow.

Please direct any questions or inquiries to:

Patrick Kennelly, Incoming Editor of
Cartographic Perspectives
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The initial idea is to run this format as an annual, having the NACIS Student Board Member conduct the interview. This would provide the student with a richer experience in their capacity as Student Board Member, as they can gain access to a luminary in the field and become familiar with the process of contributing to *CP*. We hope to pair students with either academic or professional cartographers, depending on their own career interests. As the Student Board Member for 2009-2010, I (Rob) volunteered to take a first pass to determine the viability of the series. Cindy Brewer—the person who originally suggested the interview format in the 2009 plenary—graciously agreed to be the guinea pig celebrity cartographer.



Cindy & Rob, having fun during the interview

BIOGRAPHY

In this interview, we are afforded the opportunity to hear the experiences and opinions of renowned cartographer and former NACIS President Dr. Cynthia (Cindy) Brewer. Cindy received a BA (1983) from the University of Guelph and an MA (1986) & PhD (1991) from Michigan State University under the direction of Dr. Judy Olson. After teaching stops at UC-Santa Barbara (1986–1987) and San Diego State University (1991–1994), Cindy joined Penn State in 1994, where she currently is a Professor of Geography and the Director of the Gould Center and the National Mapping Expertise Exchange <http://www.geog.psu.edu/gouldcenter/nationalmapping.html>. She also holds an Affiliate Faculty appointment with the USGS Center of Excellence for Geospatial Information Science.

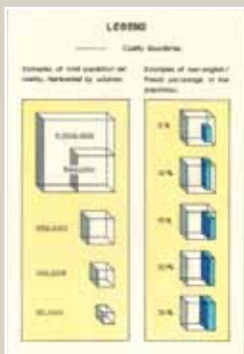
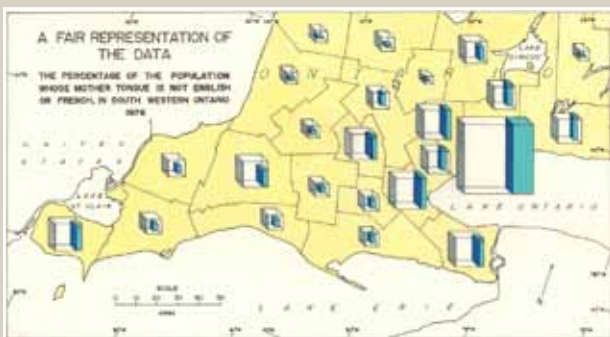
Cindy's body of work straddles the line between academic and professional cartography. She has produced approximately 75 journal articles, proceedings papers, and white papers on a variety of topics at the core of cartographic design, a half-dozen of which appearing in *Cartographic Perspectives*. She also has worked closely with professionals from the private and public sectors, penning two popular cartography books for GIS practitioners (*Designing Better Maps: A Guide for GIS Users* and *Designed Maps: A Sourcebook for*

GIS Users), collaborating with an all-star team of cartographers on the award-winning *Census Atlas of the United States*, and designing the popular ColorBrewer cartographic support tool (<http://colorbrewer.org>). Through her current research on design and generalization for federal multi-scale mapping, she participates in a research coalition of university, private, and public organizations to support the vision of *The National Map*.

INTERVIEW

Rob: Cindy, thank you for joining me today to participate in the first of perhaps a series of “Celebrity Cartographer” interviews printed in *Cartographic Perspectives*. I have with me a set of ten questions for which we think the *CP* readership will be interested in hearing your replies. To begin, let’s go all the way back to the dawn of your cartographic existence. Can you please describe the first map you ever made? If you cannot remember your first map, what was the worst map you ever made?

Cindy: The first noteworthy map that I made was for my intro cartography class at the University of Guelph. For my final project, I made a dot map portraying the population of Southern Ontario that used an abstract person symbol to represent some number of real people. All the mapping we did at that time was pen and ink on paper or, if we were lucky, Mylar; it was really tough! I was a fine arts student only taking Geography classes as a minor, so I pulled from that skill set for the final project. I carved the shape of a person into the end of a square drafting eraser and then added the thematic information to the map by dipping the eraser into blue ink and stamping it onto the page. I think it looked pretty cool; it had an artistic look because the ink had a variable density. It was really a potato print approach to thematic mapping. An echo of this first project turns up in the *CP* article on varied graduate point symbols I wrote with Andrew Campbell. I also used carved erasers for experiments on 3D cubes as point symbols for my undergraduate thesis.



Cindy's first noteworthy map, a pen-and-ink two map spread that she completed for her undergraduate cartography course.

As for the worst map I have made, there are definitely several bad maps in my past. One that I can remember was a map I made during a workshop given by Libby Wentz, a grad student at Penn State at the time and a current professor at Arizona State. She was giving the faculty a lesson in ArcView 3 I think. I made a tiny little map with a huge north arrow, scale bar, and legend. I think the title even says “This is a bad map.” She kept that darn thing and she keeps threatening to mail it around. She would delight in corroborating that story, I am sure.

Rob: On the flip side, what is the single best map that you have made in your career? Not necessarily an atlas book or series of maps, but the one, individual map of which you are most proud?

Cindy: Well, as a professor, you do not get to make very many maps; I am one of the few academics that has opportunities to take

some time out once in awhile and binge on mapmaking. I think my favorite is the reference map of Santa Barbara that I did. When I was teaching at UC-Santa Barbara as a grad, I invented a summer job for myself and several of my students at MapLink, which was run by Bill Hunt. At the time, the city didn't have a large, detailed map of this extended area along the coast. We started by tracing a US topo map, but we wound up driving many of the streets ourselves. My students and I drove all over the town, we looked up addresses in the phone book for places we knew at particular corners, and we dug into blueprints of new subdivision plans at the city office. I still have this weird effect when I visit, that I know Santa Barbara basically by heart, but I only lived there for one year, not even a whole year.

Looking at the map, I wouldn't say that it is the greatest cartography in the world, but the act of making it was wonderful. Bill is fun to work with and he knew his market. Bill was also good friends with Stuart Allan, so we did all the production and prepress work with Allan Cartography. Stuart knew the guy that ran Pikes Peak Litho, which was one of the few places at the time where you could print a large sheet with precision. We actually got bumped off the press one time because they had to print full size Michael Jordan posters for Nike. It was a unique publication route at the time and being able to work with Bill and meet Stuart—both of whom I have stayed good friends with—was a fantastic opportunity. I think I was paid a summer wage by Bill, but it was probably something less than 5 cents an hour after considering the amount of work we put into it. So, I don't know if it is the best map that I have made, but it was surely the most important map that I have made in terms of learning the trade, developing contacts, and working with students on large projects.

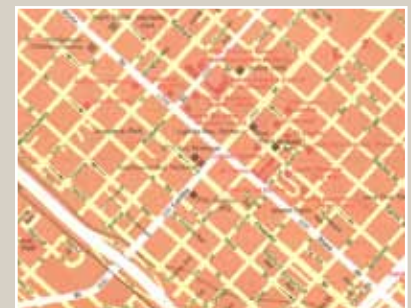
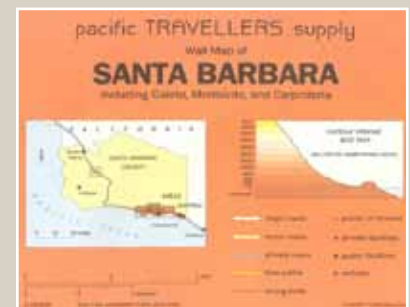
Rob: Now let's talk about some of your early NACIS and CP memories. What was the first issue of CP that you received or remember reading? Which of the early articles really sticks in your mind?

Cindy: I think my first article on color chart use for map design is in CP #4, which was based on my master's work. I don't know that I received CP #1 in my mailbox, but I have all of them; I certainly would have received CP #4. This is actually a fun story. To publish in CP in the late 1980s, people would bring a manuscript to the conference for the editor to consider—the editor being David DiBiase (who later became my husband). So I met David through CP, by going up to him, as a new PhD student, at one of the annual conferences and asking him to consider my paper.



Cindy and her students featured in the Santa Barbara Independent for their work on the Santa Barbara reference map (republished with permission)

scans of the Santa Barbara reference map (republished with permission)



To answer your second question, one of the early *CP* articles that I have read and reread was *Mapping the Nation's Physiography by Computer* by Pike and Thelin. They had printed this terrain representation as a two-page page spread. As a person with an interest in geomorphology, it was wonderful for me to be able to look into the map and see the various landforms. The article was also really a nice one to assign to students because it is explicit about calculating illumination angles from the DEM. It took what was considered magic back then and made it easy to understand; it is a readable article.

Rob: This gets to my next question. It sounds like the Pike and Thelin piece is an early favorite—do you have an overall favorite *CP* article? Is there a particular article that stands out as the one that changed your thinking, or perhaps one that has been underappreciated?

Cindy: Another early article that affected me quite a bit was Monmonier's *Ethics in Map Design: Six Strategies for Confronting the Traditional One-Map Solution*. When I was a graduate student, most researchers were asking questions like "Let's get the absolute perfect Flannery power function for proportional symbols" or "Let's get the perfect classification routine so that we can make the perfect choropleth map." Mark was saying that one map was not the solution, that one map was not the best way to understand your data. This affects how you teach your students; I changed the labs in the computer cartography classes at San Diego State from having them create a single map to having them create a map series or multiple representations of a single variable. I was not doing dynamic mapping particularly, but I wanted to get students to think about looking at their data from multiple views in order to understand it better.

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A second article that was beloved in my family is a small review that David did. There used to be a "Fugitive Cartographic Literature" section in *CP* that discussed things about maps that were found in non-cartographic places. David did a music review of the album *Big Map Idea* by an artist that he likes, Steve Tibbetts. David dug around a bit to find his telephone number and when he called, Steve Tibbetts actually answered the phone. David was flabbergasted! He has some actual quotes from the musician in the article. David likened the music, which has a Tibetan theme, to Shiva descending from the heavens. So when David sent the finished article to Steve, Steve wrote David a little note on a postcard with Shiva's figure on it.

To ask me about *CP* is really to ask me about my relationship with David; the whole "doing" of *CP* was a huge presence in our early relationship. I would come visit David and he would be cramming to finish up an issue of *CP* or working to organize a special issue on something like ethics. So the individual articles are hard to pull apart, because finding people to submit articles, editing the

submissions, and organizing the content for print was all a big part of our family for a long time.

Rob: That's a wonderful reminder that *CP* has influenced its readership not only professionally, but also personally. Moving away from *CP*-related work, what is the most challenging project you have undertaken in your career and why? What about the most rewarding and why?

Cindy: My dissertation on simultaneous contrast in map color appearance is probably the one to pick as most difficult. The dissertation is a big, multi-discipline effort and I was trying to be really careful about my experimental design. I wound up having to ask such narrow questions for controlled experiments that I was no longer having the participants complete tasks relevant to actual map reading. I could look at the participants taking the test and see that they were adopting peculiar map reading strategies. If they were looking for a particular color or trying to compare two colors, I could see them blur their eyes or look away slightly so that they were viewing the map out of peripheral vision. They found strategies that worked for the experimental conditions, but these strategies were not what they would do when actually trying to use a map.

On top of this, I believe I observed what is called the fast-same effect in psychology. In these controlled experiments, people are able to say much faster that two things are the same than they are different. This effect wound up polluting my results, as there was a significant difference in response time when the color chips were different, but not one when the color chips were the same. When you are working at that very precise level of response time testing and measuring accuracy, and also plotting very tiny color differences onscreen, you are down in the weeds so deep, worried about things like the particular color model or the fast-same response affecting your results, that you are not learning much about actual map reading. Generally, I liked the results of the research, and I even received a Nystrom Award from the AAG, but the issues with applying highly-simplified, psychology-based perceptual testing to complex displays put me off from doing much more of that kind of research. The lesson is to try to test in realistic situations.

Another lesson from this research is to test a large number of maps. In my design work with federal agencies, like the Census Bureau, USGS, and NCI, by definition I was working with hundreds of maps (the *Census Atlas* has over 800 maps), never mind an experiment sample of 30. It does not do you any good to test one particular map, or one particular arrangement of colors, or a single dataset that has a single spatial distribution across the map. It makes me really skeptical of research conclusions I see that are based on one map or two maps or two color schemes. Because there are so many permutations of testing

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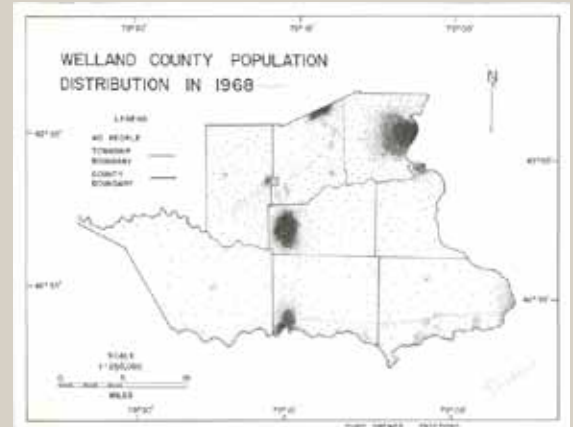
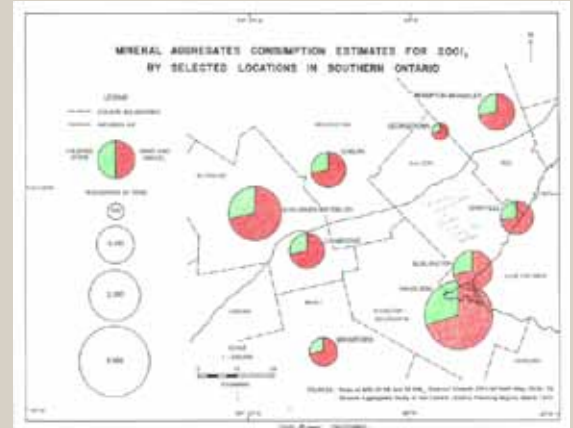
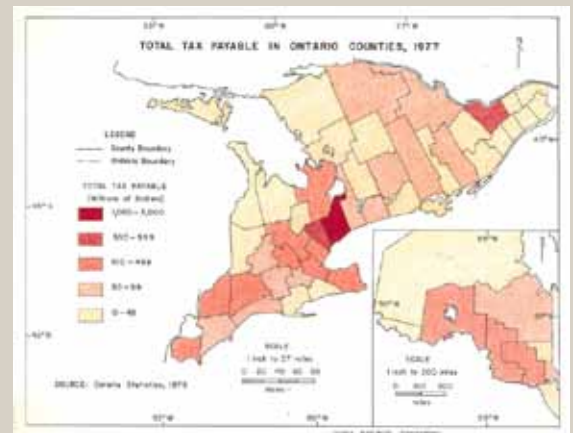
Rob: So you consider being able to design a good map while keeping the underlying data live as the biggest development in Cartography over the past several years. Looking into the future, what do you think is the biggest challenge for Cartography in the next several years?

Cindy: While GIS environments are starting to allow good quality cartography, there are still bottlenecks in the datasets. Many times, there just are not any attributes that allow you to apply appropriate cartographic symbolization. This is less a challenge within Cartography and more a plea to the data collectors that cartographers cannot be an afterthought. The data needs to be constructed from the beginning to allow it to be represented. The tools are now there to get the data on the map pretty quickly and in a sophisticated manner, so the attributes needed for good cartography can no longer be ignored during data creation.

Looking forward for academia, I've switched my approach in the introductory cartography course from an emphasis on thematic mapping to an even split between thematic and reference mapping. Reference mapping is where the big competition in "look" is happening. Just look at the sophisticated reference maps that are provided by Google, Yahoo!, and Bing; they are jockeying for number of users based on functionality in part, but also a lot based on look. So, the look of reference maps is really prominent in the way Cartography is viewed currently. This also shows up in federal mapping, like the US topo maps and the National Parks maps. I think, as academics, we really put ourselves in a backwater solely trying to find the next perfect thematic symbol, because there is a lot less of that going on in proprietary and government mapping. My current work on multi-scale mapping, compared to my past work on color, is a good example of my shift from thematic to reference map research.

Rob: So this is the last of my hard questions, and it may relate to the last two questions that I asked you. If you had the world's attention for five minutes to tell them about maps, mapmaking, and Cartography, what would you say? What would be your message?

Cindy: Good design is transparent, but that does not mean it was effortless. If you have a map that works really well, it is because someone worked really hard to design that information. They stripped away gobs of detail that would distract you from the message and put just the



Cindy completed four pen-and-ink thematic maps in her undergraduate cartography course prior to her final project. She now recommends a more even split between reference and thematic mapping labs when teaching Cartography at the university level.

right information on the map for its purpose. That takes a lot of skill; it is not something that the GIS does for you. The GIS gives you lots of data and lets you manipulate this data, but it does not help you select the appropriate data for the map, select the correct map scale and generalize the data accordingly, and come up with symbols that are legible and that stand out—it doesn't do any of that for you.

I think cartographers do not yet know how to demand that design be a priority, or frankly to get paid for doing it, because the final result looks like it was easy to produce. That good design is effortless is just not true. It is not easy. It takes a lot of skill. Periodically, a student will come to me with a freelance opportunity and ask what rate they should charge. I always push them, "You know how to do a lot of stuff. You have a lot of skills. You know how to use computers, you know GIS, you know graphic design software. Charge for it! Charge \$35 an hour!" They usually look at me like I am out of my mind. Cartographers just generally undervalue their skills, and again I think it is partly because when you do it right, it looks effortless. I want cartographers to recognize that their design skills have value. In the end, I think that good design will out-compete bad design, regardless of the reality of cost.

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Rob: Let's end with two easy, fun questions. First, what do you think is the most commonly violated cartographic convention or guideline? To put it another way, which guideline would make the biggest improvement in the complete body of maps if everyone followed it?

Cindy: Definitely establishing an appropriate visual hierarchy. This is a guideline that is violated on really a majority of maps, particularly those generated with GIS software. It is so important to push some or most of the content into the background, allowing the key content to rise to the foreground. It is also important to know when to remove items from the map, but I think establishing a good visual hierarchy is equally as important.

Rob: Last question: if you had to choose, would you choose conformal or equivalent?

Cindy: Equivalent of course! So many people map statistical data with a projection that severely distorts areas. When you are trying to have people understand a distribution, but show it on geographic areas that get bigger as you go farther north, or stretch east-west because you haven't bothered to select a projection, then you are misinforming the reader even if your data are accurate.

Rob: Thanks Cindy. I have enjoyed our conversation, and I suspect the CP readership will be interested in your experiences and opinions.

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