Is your map here? A well-designed interface design will help you answer this question quickly

J. Gelernter and M. Lesk

ABSTRACT: This paper considers best practices of interface design of systems which find already-created maps by collecting examples of how people ask for maps and considering how their modes of query might be abstracted into an interface mechanism. It proposes design principles for such interfaces and offers one realization of those principles. We found that actual queries conform to categories of region, time and theme, and so we propose that an interface also include region time and theme facets in words rather than pictorially so that the categories will balance, so that non-map data might join the corpus easily and be organized similarly, and so that the product will harmonize with the geospatial web.

Introduction

An interface enables system functions, navigation and content display. Miller backs Apple Computer, Inc. in supposing that the success of any multimedia mapping product is determined primarily by its Graphical User Interface (GUI) (Miller, 2007). But what features should a system have to enable those functions? This paper considers what features people ask for when they are looking for maps, and proposes a system to automate asking those questions of digital maps.

Collections of digital maps have been called geolibraries. The collection may be composed of scans of printed sheet maps or maps extracted from atlases or publications, or include maps that have been born digital in web pages or in mash-ups (maps made by combing data from different sources). Ready-made maps are needed to show non-topographic information such as archeological sites, battle histories, climate data, land use, or population density. All maps scanned from print are of fixed size and limited resolution, which restricts viewing and analysis tools (Suchan, 2002). Examples of geolibraries that hold scans of printed maps are the Perry Castaneda collection of the University of Texas at Austin, the scientific maps of the National Geologic Database, and the commercial David Rumsey collection.1

Organization of geolibraries typically is by logical groupings among maps themselves: determining what map types or subjects recur and creating categories according those groupings. An alternative approach would be to organize maps according to categories that are external to the map collection. Keyword search of map libraries might draw blanks for those who lack familiarity with a smaller, more specialized corpus. Search by geographic coordinates is provided in Google Earth, the Alexandria digital library, and Grifinor,

1 Perry Castadena at http://www.lib.utexas.edu/maps/ ; National Geologic Database at http://ngmdb.usgs.gov/; David Rumsey at http://www.davidrumsey.com/.

but it has been found that search by latitude and longitude is not highly desirable (Sandusky & Tenopir, 2008, 977).

Even with specialized map libraries, many look for maps with the help of general search engines. An experiment conducted in 2001 with high school and college freshmen and repeated in 2005 with college juniors showed that finding a continent map was easy, finding a .pdf version of a map slightly more challenging, and creating a map more frustrating—at least for some in the 2001 trial (Peterson, 2006, p.123).

How should digital maps be organized to give the user maximum search flexibility? This paper attempts to answer this question by performing a study of how people ask for maps, then making some inferences based on the data about how a map search interface should be organized. Retrieval behind that organization is improved by ontologies for region, time and theme. Both the organizational backbone and the underlying ontologies would allow the collection to expand beyond maps to other media.

Our objective in this paper is to find patterns in non-specialists' map questions in order to design an interface that facilitates entering such questions easily on a system interface. Studies of those who use geospatial software is a valid alternative approach to interface design (Suchan, 2002). Our method, by comparison, should suggest design principles that are more generalizable because our data comes from a wider pool of those who are inquire about maps.

We canvassed those who field hundreds if not thousands of map questions in order to cover the widest possible range of library users and improve model generalizability. In addition, we intend for the model to be scalable in terms of map content. Further research would extend the model to cover spatial queries that do not hope to uncover maps and map-related data specifically.

In the paper as follows, § 2 reports on research related to our study of map queries, then outlines our experiment and recounts our findings. § 3 reports on related research on interfaces generally and spatial interfaces in particular as preliminary to explaining how our experiment results can inform the design of a spatial interface. § 4 extracts principles of design that might apply to similar map search interfaces and § 5 presents an example of one such interface. § 6 offers future directions for research, while a summary is in § 7.

2. How do people ask for maps?

2.1 Related research

The research question has been posed by others in a more general vein: how do people ask for geographic information? The answer comes from combing search engine logs for geographically-related queries, that is, queries that contain place names. Researchers have characterized geographical queries by topic, time, scale and by type.

Geographic queries have been categorized into topics including Tourism/Travel, Government, Real Estate, Education, Business and E-business, Night Life, Medical, Media, Employment, Automotive, Civic, People, Entertainment (Gan, Attenberg, Markowetz, Suel, 2008, p. 52).[2] Geographic queries posed over the web frequently aim to locate goods and services (ibid, p. 51) in the present time. Geographic queries also have been characterized by scale, or the search radius between location and landmark (Delboni, Borges, Laender, 2005, p. 62). The authors refer to this as positioning.

Geographic queries also could be characterized by type. Baptista and Kemp developed a geospatial model for a digital library that included region, time, theme and medium data (Baptista and Kemp, 2000). Perry, Hakimpour and Sheth propose that space, time and theme should be considered as retrieval elements for a basic web search system (2006). Kemp, Tan and Whalley call these three the "space-time-theme composite" (2007, p.84).

Our research concerns not geographic information in general, but a particular form of geographic presentation – the map – and so it is queries about maps specifically that we study.

2.2 How do people ask for maps?

This section presents two case studies for how people actually ask for maps. Two studies allow us to collect two different types of data, even when the region, time and theme codes for both data sets were the same to allow for comparison. Then we compare findings of the two studies to determine whether code results conflict or reinforce each other. But what do region, time and theme codes mean in the language generally, and in the context of how people ask for maps?

Region

A place word denotes some bounded region (Uganda, downtown). The person who asks for a map of some location may intend for the map to show that location only, or that location surrounded by – but probably not dwarfed by – neighboring locations. For example, many maps of New Zealand will point out the capital, Wellington, but a person who asks for a map of Wellington almost certainly wants a large scale map of the city rather than a map of the country. *In essence, a query for a location is key to the desired map scale.*

Time

Maps usually show land. The time implied by a non-dated map of the land is the [cartographer's] present. The person who asks for a map of a village in Eastern Europe in 1910 probably wants a map that was made around 1910. How should a map be dated that shows Neanderthal burial sites? Should that map be considered current because it shows sites of modern excavations, or should it be dated as prehistory because it concerns Neanderthals? *In our context, the*

2 The entire topic list is not given because many topics such as "Undirected", "Closed", "Obtain", Downloads", "Interactive" and "Navigational", are internet-related rather than subject related.

time period of the map is implied by the map theme, and a Neanderthal burial site map would be categorized as prehistoric.

Theme

All maps are tools of geography, but geography is not the theme of every map. We can tell the theme either from the map itself or from its context. Two maps that look the same would be said to have different themes if they were created to illustrate different ideas. For example, the same map of New Zealand with a label on Wellington could have a theme of government if illustrating a report on international relations, or a theme of homeland security if illustrating a military brochure. *The person who looks for a map on a particular theme, therefore, might be satisfied either with a layer of data above the geographic base that pertains to that theme or with a map illustrating a discursus on that theme.*

2.3 Frequently-occurring map questions

2.3.1 Method

Data for the first study was collected from those who field large numbers of map queries daily: map librarians. These have heard many questions over the course of their careers. Each was asked to choose the 10 questions that the librarian had encountered most frequently. The "poll" was taken between December 2007 and May/June 2008. The librarians asked were those at the New York Public Library Map Division, the University of Chicago map library, the John Borchert Map Library of the University of Minnesota, the map library of the University of Michigan, the map collection of the National Library of Scotland, the map library of the United Nations, and the map library of the University of Georgia { + Ohio were there 8 altogether? Consult other computer}

2.3.2 Sample data from the New York Public Library Map Division

Data: recurring questions	Code
I need a Sanborn map [current, for NYC address].	{theme+region}
I'd like to see a map of ... [some area or place, e.g. a region in Pakistan, France, Tierra del Fuego, Nevada].	{region}
I need a Sanborn map from before 1961 [usually for a Queens or Brooklyn address, relating to a grandfathered zoning issue].	{theme+time+region}
I'd like to see a series of fire insurance/real estate maps through time for a site or neighborhood in NYC.	{theme+time+region}
I'd like to see a series of fire insurance/real estate maps through time for a site or neighborhood [outside NYC, most often NJ].	{theme+time+region}
I'd like to see a series of maps through time that show the development of [such and such] an area. (May be city plans or other region maps; may relate to wetlands or other particular kinds of natural or man-made changes such as shoreline or roads.)	{theme+time+region}
I'm trying to locate a place/village in [Central/Eastern Europe, Ireland, Italy] from [some time usually before 1920].	{time+region}
Can you help me find some information about an old map that I have?	

	{region}
Can you help me locate this [place/address/cemetery/church]?	{theme+region}
I'd like to find out what was previously on [such and such a site].	{theme+time+region}
I need a site plan [or large scale contour map] for a site in [a particular city].	{theme+region}
I need to see some maps to get some design ideas for [such and such a project; may be related to cartography, publishing, textiles, theater, whatever].	{not coded}

2.3.3 Findings

One of the twelve questions was not coded because it does not relate to any specific region, time or theme. Of the eleven remaining: three concern region + theme and either assume the present day or are not time specific, five concern region + time + theme, one concerns region + time, and two region only.

Of the total 80 {CHECK} questions related by map librarians as most frequently occurring, 95% conformed to the region/time/theme indexing codes.

2.4 Actual map questions

2.4.1 Method

The Internet Public Library provides resources and reference services. It serves children largely, although not exclusively. The following questions were drawn via keyword search on “map” and “geography” from over 60,000 of those which patrons emailed to staff at the Internet Public Library during 2006 and 2007. They were reported courtesy of Ms. Crosby, the Assistant Director for User Services of the Internet Public Library (personal communication, 2007).3

The same codes were used for this study: region, time and theme. Outstanding characteristics of questions merited a code. Mark how detailed are the requests for dates and themes as well as places. The data appear below.

2.4.2 Data

The questions below are listed in no particular order and are coded for region, time and theme.

Where can I find a detailed, yet easy to read world map of mountains, rivers, lakes seas, deserts – that I can either find online or at the library that I can check out?	{theme+region}
I am looking for images of maps of Detroit, MI. I specifically need three maps, one from before 1943, one from between 1943 - 1967 and one from after 1967. The closer they are to those dates, the better they will be (for example, a map from 1886 won't work, but one from 1930 will work).	

3 Our formal request to examine query logs from the Microsoft live search engine was rejected in December 2007.

{time+region}

I really don't know anything about … the city is called Ramnicu Valcea (or Rimnicu Vilcea) which is located in southern Romania in Wallachia. I've searched on the web and I can't find any information that I want. I've already tried the local libraries near and at my community but there is no information at all. Mainly what I've been looking for are detailed maps of the city in the year 1845, 1988 and recently, showing the name streets and showing a little outside the city as well. I would also like more knowledge on the history, and culture of the people. Pictures of the city has [sic] also been a difficult thing to find, I would very much like to see what the city looks like: streets, shops, etc. Please, any information at all and that I've requested would help.

{theme+time+region}

I am a fifth grader, and am in the middle of a state report. I am doing New Jersey and I need a good place to find printouts of a topographcal [sic] map, a political map, a points of interest map, and the New Jersey state license plate.

{theme+region}

How to find maps of Maine, MA and Halifax, Nova Scotia Canada dating back to the 1800's

{theme+region}

How might I get access to walking maps of Paros, Naxos and Crete, islands of Greece, electronically or in print?

{theme+region}

Hi. I want to write a triology [sic] story based on fantasy. So I was wondering whether you can find me a map of a place, a historic place, where I can base my story in? And also, could you email th [sic] map to me? By the way, I'm 13 and I want to take a carr [sic] as a childrens' book writer. {time+region}

What is the elevation of Crowley's Ridge, Ar, where it is intersected by the pioneer (circa 1865) Southwest Trail (aka Military Road) between Memphis, Tn and Fulton, Ar? Any description of terrain, flora and fauna would also be helpful. I'm planning to describe how a Conestega wagon would cross at this point.

{theme+region}

What river in Massachusetts is at the highest elevation?

{theme+region}

I need to know the Physical setting of Visalia, CA elevation, physical features how the physical setting affects the weather, climat [sic], Native flora, Native fauna [sic]?

{theme+region}

2.4.3 Findings

All 10 questions fit within the three codes of region, time and theme. Seven represent region + theme, two represent region + time, and one represents region + time + theme.

2.5 Interpretation of both studies

The case studies of frequently-occurring questions and the actual questions suggest that map indexing should include region, time and theme. That map indexing can be reduced to a few basic points of indexing seems to contradict the complex metadata schemes that have been set up for map cataloging. While it is undisputedly useful to know the source of each map, its scale, date of creation, and so on, such as are provided in many map cataloging schemes, these are not necessarily critical to “the user” in defining a search. More research is called for in defining how particular user communities look for maps, with the proviso that some quite useful information is not readily available through indexing that is automatic.

What do the patterns of coding show for a potential interface? (1) How best to index the maps based on facets employed to search, and (2) how to set up an interface to facilitate actual search patterns. When map data are combined with other sorts of geospatial data, documents and web pages, the same indexing facets will pertain.

3 Related research on geospatial and related interfaces

3.1. Interface home screen

Faceted browse categories and controls have been arranged variously on screen. This section presents some alternative arrangements.

Basic to a faceted browse interface, in the estimation of Stuart-Moore, Evans & Jacobs (2006), is that a keyword search alternative to browse should be available, that it should be possible to select more than one browse category at one time, and that the user should be able to select facets in the order of preference.

The Zhang and Marchionini interface includes browse facets as a screen overview, with keyword search in middle, and retrieved results at screen bottom (Zhang & Marchionini, 2004).

Goodchild, Montello, Fohl and Gottsegen (2002, p.207) suggest that the user should have the option to represent a vaguely-defined region differently than when a discrete region is meant.

Kajiyama, Kando and Satoh (2005) break with the divided pane precedent to situate browse facets around a ring. Categories mark the ring's inner subdivisions. They call the outer circle a category ring, and the subdivisions the key rings. Results are retrieved in the rings' center. Because the results are not retrieved in list form with the most relevant at top, alternate means must be used to demonstrate relevance. More relevant results are displayed larger than others.

Dachselt, Frisch and Weiland (2008) content that current faceted browse approaches do not scale well in terms of screen size. Their FacetZoom interface combines space-filling choices with an interaction style that enlarges a choice selected to permit more efficient layout. Their facets are not vertical lists but instead, horizontal bars. Their navigation control to change levels is abstracted into a bar-like widget. No user studies were conducted so it is unclear how well their layout is appreciated.

Despite these attractive alternatives to the simple vertical list, the simple list is a prevalent, often-used way to condense information. It is familiar, and therefore at least somewhat comfortable to use and liked. The most familiar system was found to be best liked among alternatives in at least one usability study (Capra, Marchionini, Oh, Stutzman & Zhang, 2007, p. 451).

3.2 Interface navigation, controls and filters

Controls, distinct from category choices, may be used for the navigation of hierarchies or for refining a query or results filtering. Controls are especially important in a faceted interface in order to allow the user to jump levels rather suffer the repetition of retracing his path. They are also important to help users regain focus after searches that lead nowhere. Such is the function, and courtesy of the error message.

A number of systems allow users to input searches visually, by clicking a location on a map as on the IDIOM prototype (Scharl, Stern & Weichselbraun, 2008). Graphic controls are also a means of refinement, as in the Google Labs timeline browse, in which users can select a unit of time based on the number of results retrieved, and narrow the time units, as from decades to years.

3.3 Interface: Results screen

The results screen might show what search the results are for. The search input mechanism could remain visible along with the results, as in the relational browser of Zhang, and Marchionini (2004), or even on the Google results screen. Another option rather than crowd the screen with the search, however, is simply to describe the path. This is the solution taken by Yahoo for the browse results.

The results themselves may be grouped them in order of relevance. Alternatively, the data may be displayed in clusters, in which each cluster demonstrates a different center of relevance. Albertoni, Bertone, and De Martino (2005) have derived an abstract way of representing the result set. Retrieved results, while relevant to the query, might be ordered differently depending which attribute is most relevant – date, file size, etc. Three-dimensional visualizations of the data, with mixed usability ratings, have been found in at least one study as viable alternative to the ranked list (Hobona, James and Fairbairn, 2005, p.7).

4 Interface principles for map search

Coupling many of the ideas from geospatial systems as stated in the section above with basic ideas from design experts Shneiderman and Plaisant (2005) and Krug (2006), we offer some basic principles for an interface for those searching for maps. Each principle is explained and justified below.

1. Provide a browse hierarchy to give an overview of digital library contents
    a. Divide into three facets for the region, time and theme categories as found consistently in queries for maps
    b. Provide the number of retrieved by a search, thus saving the user clicks when a formulated search will reap no results or thin results

2. Provide a search box for the option of the familiar Google-type environment

3. Provide visual input means if each of the input categories can be abstracted (place can be visualized by a map and time by a line, but theme cannot be abstracted easily). If the data is potentially expandable to textual as well as visual documents, as is the case here, a textual interface might be acceptable.

4. Maintain the search hierarchy on the results screen so that a user remembers the search that reaped particular results and can re-formulate a new search easily.

5. Give an message to help users re-cast an ill-formed search to better effect the next time.

6. Provide options on the results screen to privilege either the number of results (smaller titles with more on the page) or to privilege detail of each particular result (giving larger tiles or more metadata per result).

7. Provide options to order retrieve results in different ways depending upon which aspect of the results are preferred (file size, color or clarity, for example).

[Information visualization preference of many people (see my study)]

The principles of interface design are descriptive rather than prescriptive. That is, we offer them in the spirit of what we feel describe a usable system best. We are not yet in a position to prescribe them to all systems in all cases, believing that best practices might depend to some degree on the corpus and the particular tasks of the users. These principles are for a general audience and the general case only.

5 Prototype interface

The prototype system illustrates the basic principles stated in the above section. Note in figure 1 (below), the facets could have reflected query distribution more precisely had we divided the screen about 20% for time facet, 40% region, 40% theme. However, we elected to divide the facets equally for the sake of balance.

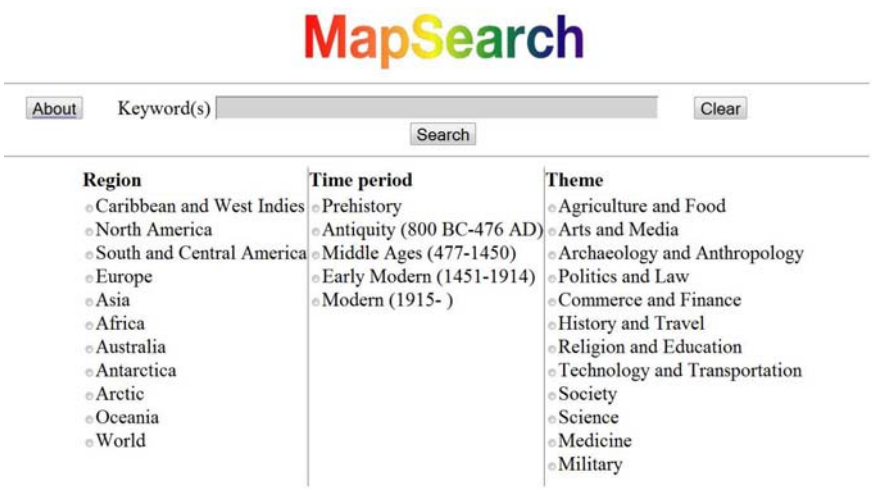

Figure 1 (above): MapSearch interface

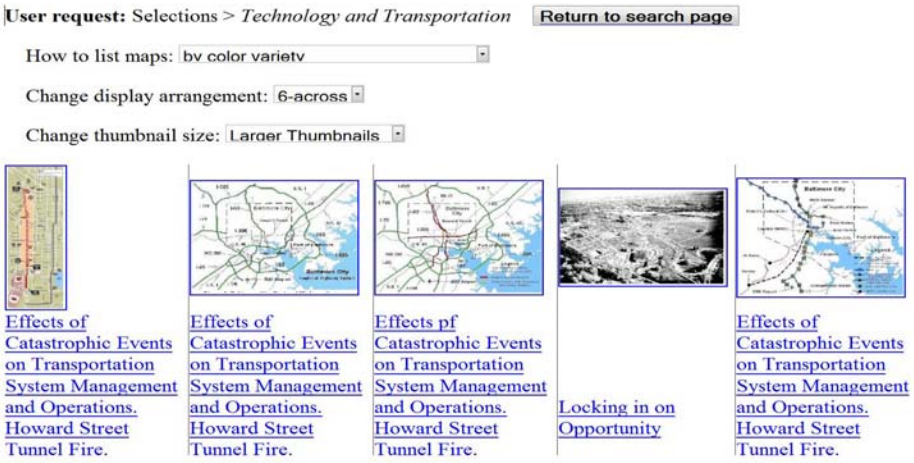

Figure 2 (above): Results for search on Technology and Transportation, with maps listed by color variety.

6 Future research

Our examination of map queries is solid in its multi-perspective data. However, only the first set of queries from map librarians is a reasonable size to generalize. Further research should entail analysis of a much larger sample of actual queries submitted to the Internet Public Library, or even better, to a variety of sites that offer map reference.

We have proposed an interface based on user data, but we would like to test that interface as well. A standard usability experiment would be to create a series of questions that can be answered with the maps in the digital library, and ask users to search the library using the interface and answer those questions. After which, the users would be in a position to evaluate their experience with the interface based on scaled Likert rating on interface efficiency and ease-of-use. Details of interface content could be analyzed as well. For example, are the ranking options to list items according to data and color useful, or would other options be more valuable?

Future systems will answer questions in addition to displaying data. We would like to teach a system to understand and interpret the maps that it holds so that it may answer questions based on those maps. The digital library might expand beyond maps to different types of data and types of questions asked might also expand, suggesting a wider range of question input features. The inter-face is only as suitable as the body of its contents and the audience of its users.

7 Significance (advantages acknowledging limitations), and Conclusion

We presented two studies of how people ask for maps. The two different data sets (librarians summations of the most frequently asked questions they had heard) and the random sample of actual map questions yielded the results: questions can be coded according to region, time and theme. Frequently asked-after map attributes of region, time and theme we recommend therefore should be reflected in an interface to search maps. We reviewed characteristics of a number of interfaces for finding maps, and collected attributes that tested well and seemed to rate positively with users. Combining our user study and our review of map interfaces allowed us to extract some principles of map interface design, which we them demonstrated in an interface.

We have stressed here not the technology itself (Ragowsky, Licker, and Gefen, 2008), but the way that the technology guides users in expeditiously finding what they seek. And we have set out a method for improving information architecture on the basis of examination of actual search queries.

J. Gelernter and M. Lesk, Rutgers University, 4 Huntington St., New Brunswick, NJ 08901 U.S.A. {gelern}{lesk}@scils.rutgers.edu

References

Albertoni, R., Bertone, A., De Martino, M. (2005). Visualization and semantic analysis of geographic metadata. *Proceedings of the 2005 workshop on geographic information retrieval*, N*ovember 4, 2005, Bremen, Germany*, 9-16.

Baptista, C. S. (2002). A geolibrary for multimedia data sets: Design and implementation issues. Proceedings of the 2002 ACM symposium on Applied computing Madrid, Spain, 488 – 492.

Baptista, C. S. & Kemp, Z. (2000). An integrated metamodel for knowledge representation in geolibraries. *Advances in Digital Libraries, 2000. ADL 2000. Proceedings. IEEE May 22-24, 2000, Washington, D.C USA*, 151 – 159.

Capra, R., Marchionini, G., Oh, J.S., Stutzman, F., & Zhang, Y. (2007) Effects of structure and interaction style on distinct search tasks. *JCDL '07 June 18-23, 2007, Vancouver, British Columbia, Canada*, 442-451.

Dachselt, R., Frisch, M. & Weiland, M. (2008). FacetZoom: A continuous multi-scale widget for navigating hierarchical metadata. *CHI 2008, April 5-10, 2008, Florence, Italy*, 1353-1356.

Delboni, T. M., Borges, K. A. V., Laender, A. H. F. (2005). Geographic web search based on positioning expressions. *Proceedings of the Workshop on Geographic Information Retrieval, November 4, 2005, Bremen, Germany*, 61-64.

Egenhofer, M. J. (2002). Toward the semantic geospatial web. *Proceedings of the 10th ACM International Symposium on Advances in Geographic Information Systems, November 8-9 2002, McLean, Virginia*, 1-4.

Gan, Q., Attenberg, J., Markowetz, A., Suel, T. (2008). Analysis of geographic queries in a search engine log. *LocWeb 2008, April 22, 2008, Beijing, China*, 49-56.

Gelernter, J. (2007). Information Visualization for Digital Libraries. *Knowledge Organization 34*(3), 128-143.

Goodchild, M. F., Montello, D. R., Fohl, P. & Gottsegen, J. (2002). Fuzzy spatial queries in digital spatial data libraries. *Annual Meeting of the North American Fuzzy Information Processing Society, 27-29 June 2002*, 377-382.

Hobona, G., James, P. & Fairbairn, D. (2005). An evaluation of a multidimensional visual interface for geographic information retrieval. *Proceedings of the 2005 workshop on Geographic Information Retrieval, November 5, 2005, Bremen, German, 5-8.*

Kajiyama, R., Kando, N. Satoh, S. (2005). Examination and enhancement of a ring-structured graphical search interface based on usability testing. *SIGIR '05, August 15-19, Salvador, Brazil*, 623-624.

Kemp, Z., Tan, L, & Whalley, J. (2007). Interoperability for geospatial analysis: A semantics and ontology-based approach. *Proceedings of the eighteenth conference on Australasian database vol. 63. ACM International Conference Proceeding Series vol. 242. Ballarat, Victoria, Australia*, 83-92.

Krug, S. (2006). *Don't make me think! A common sense approach to web usability* (2nd ed.) Berkeley, CA: New Riders.

Lieberman, M. D., Samet, H., Sankaranarayanan, J., & Sperling, J. (2007). STEWARD: Architecture of a spatio-textual search engine. *ACMGIS '07, November 7—9, 2007, Seattle, WA*, 1-8.

Miller, S. (2007). Design of multimedia mapping products. In W. Cartwright, M P. Peterson & G. Gartner (Eds.) *Multimedia Cartography 2nd Edition* (pp. 89-104). Berlin: Springer.

Perry, M., Hakimpour, F. & Sheth, A. (2006). Analyzing theme, space, and time: An ontology-based approach. *Proceedings of the 14th ACM International Symposium on Geographic Information Systems, ACM-GIS 2006, November 10-11, 2006, Arlington, Virginia, U.S.A.*, 147-154.

Peterson, M. P. (2006). Hypermedia maps and the internet. In E. Stefanakis, M. P. Peterson, C. Armenakis & V. Delis (Eds.) *Geographic Hypermedia: Concepts and Systems*. (pp. 121-136). Lecture Notes in Geoinformation and Cartography, Series Eds. W. Cartwright, G. Gartner, L. Meng & M. Peterson. Berlin: Springer.

Ragowsky, A., Licker, P. S., and Gefen, D. (2008). Give me information, not technology. *Communications of the ACM 51*(6), (June 2008), 23-25.

Sandusky, R. J. & Tenopir, C. (2008). Finding and using journal-article components: Impacts of disaggregation on teaching and research practice. *Journal of the American Society for Information Science and Technology 59*(6), 970-982.

Sharl, A., Stern, H. & Weichselbraun, A. (2008). Annotating and visualizing location data in geospatial web applications. *LocWeb 2008, April 22, 2008, Beijing, China*, 65-68.

Shneiderman, B. & Plaisant, C. (2005). *Designing the user interface: Strategies for effective human-computer interaction*. 4th edition. Boston: Pearson.

Stuart-Moore, J., Evans, M. & Jacobs, P. (2006). Interface design for browsing faceted metadata. JCDL '06 June 11-15, 2006, Chapel Hill, North Carolina, USA, 349.

Suchan, T. A. (2002). Usability studies of geovisualization software in the workplace. Proceedings of the 2002 annual national conference on Digital government research: ACM International Conference Proceeding Series; Vol. 129, 1-6.

Zhang, J. & Marchionini, G. (2004). Coupling browse and search in highly interactive user interfaces: A study of the relation browser++. *JCDL '04 June 7-11, Tuscon, Arizona, USA*, 384.