CO-037

CHALLENGES AND OPPORTUNITIES FOR WEB-BASED EVALUATION OF THE USE OF SPATIAL TECHNOLOGIES

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INTRODUCTION

Since the 1990s there has been sustained interest in the geography research community focused on user-centered design and evaluation of GIS, geographic visualization, and other spatial technologies (Haklay 2010). The rapid development of new interactive geographic software systems and associated devices brought about a corresponding need to develop and implement best practices for evaluating such advances against what users need and can effectively apply. A wide range of evaluation research with spatial technologies has included, among many other examples, the development of usable geovisualization tools (Edsall 2003), geographic digital libraries (Buttenfield 1999), and geospatially-aware mobile devices (Chincholle, Goldstein et al. 2002).

The continued proliferation of new spatially-enabled tools and methods makes evaluating the utility and usability of such technologies more important than ever. For virtually all technological advances, we must also increase and formalize our understanding of how people can make use of such advances. Typically, we pursue this goal through methods of inquiry that include techniques from disciplines like human-computer interaction, ethnography, and cognitive psychology. For researchers focused on applying such methods in cartographic research, there are now a wide range of examples to build upon. Most contemporary research on use and user issues with spatial technology employs in-person methods that require direct interaction with one or more users. Such studies provide invaluable feedback and opportunities to delve deeply into use and user issues. However, there can be substantial costs associated with gathering participants in a single location, and it can be difficult to recruit domain experts if they are required to leave their workplace in order to participate.

A DISTRIBUTED, WEB-BASED APPROACH FOR USER STUDIES

One way to circumvent these challenges is to develop and utilize distributed, web-based approaches for conducting user studies of spatial technology. While such approaches have their own immediate weaknesses, (the ability to capture rich verbal protocols or interview dialog, for example) web-based approaches can cost less to conduct and it may be substantially easier for domain experts to participate if they can decide when and where they would like to contribute their knowledge.

Conducting user research at a distance via the internet is a topic that has received substantial attention in the human-computer interaction community. Multiple studies have sought to evaluate the differences between in-person and distributed asynchronous approaches. One such study compared lab, remote synchronous, and remote asynchronous methods for evaluating the usability of an email client (Andreasen, Nielsen et al. 2007). This study found that the traditional lab and remote synchronous methods yielded nearly identical results, and that the remote asynchronous approach yielded lower quality results, but sufficient results nonetheless to justify its use in cases where synchronous evaluation was not possible. A similar study comparing traditional and remote methods yielded similar results, suggesting that while remote methods do not reveal the same number of usability issues, they still have the potential to reveal a substantial number of issues, and can do so with minimal cost to researchers (Bruun, Gull et al. 2009).

To date, only limited attention has been given to the use of remote methods to evaluate spatial technologies. One exception is work by Marsh et al. (2006) to compare a remote instruction approach to face-to-face evaluation of a census data geovisualization tool. Marsh et al. found that both methods yielded useful results, but the face-to-face think aloud approach seemed to reveal the most about the character of users' interactions with dynamic geovisualization tools. To build on these findings and elaborate on the potential for distributed usability methods for the design of spatial technologies, the following sections describe our recent research experiences with three case studies, with a focus on their methodological design and resulting key outcomes.

CASE STUDY: DESIGN AND EVALUATION OF AN INTERACTIVE CANCER ATLAS

Our first study to make use of distributed methods for conducting user evaluations focused on the design of an interactive cancer atlas. The Pennsylvania Cancer Atlas (PA-CA) is a web-based interactive atlas designed to help policy-makers, program managers, and epidemiologists with cancer prevention and control tasks. The PA-CA supports visually-led exploratory analysis and decision-making with

spatiotemporal cancer data. The intended users for the PA-CA are state and national health agencies charged with planning, implementation and evaluation of cancer morbidity and mortality reduction efforts.

As part of a user-centered design process to develop the PA-CA, we devised a distributed, web-based user evaluation mechanism for eliciting expert and end-user feedback. As we began working on the iterative design and evaluation of PA-CA, it became clear that we needed expert user feedback from both domain experts as well as visualization experts, and that those participants were located across the United States and it would be very difficult and expensive for us to gather them in a single location at the same time to participate in an evaluation.

Our solution to this problem built upon the progress made in earlier research to create e-Delphi, an online collaboratory designed to support communities of scientists as they collaborated to develop, compare, and probe their shared knowledge on nature/society related issues (Pike and Gahegan 2003). The e-Delphi platform supports round-based moderated discussion and voting activities. All participation is anonymized to reduce the chance that personal or power relationships can impact the discussion. After each round of discussion a moderator distills what has been learned and can create polls to vote on the next issues to discuss or a particular course of action. Ultimately, e-Delphi emulates many of the key components of traditional Delphi exercises (Dalkey 1969) and extends the Delphi method to a web-based application to support different-place, different-time collaboration.

To help evaluate the PA-CA, we used the e-Delphi platform (Figure 1) to elicit feedback from domain experts in public health and visualization in two separate user-centered design activities (for details, see Bhowmick, Robinson et al. 2008). We wanted feedback from both groups on our initial designs for the PA-CA interface, and to elicit this feedback we used e-Delphi to collect answers to survey questions and discussion prompts created for each expert group. In multiple rounds with each group we were able to elicit high quality feedback on our design and feed these results into the continued development process of the PA-CA. A moderator from our team helped structure each round of these evaluations to probe emerging design issues where they were noted, and to create polls where it was necessary to choose between multiple options for future PA-CA designs.

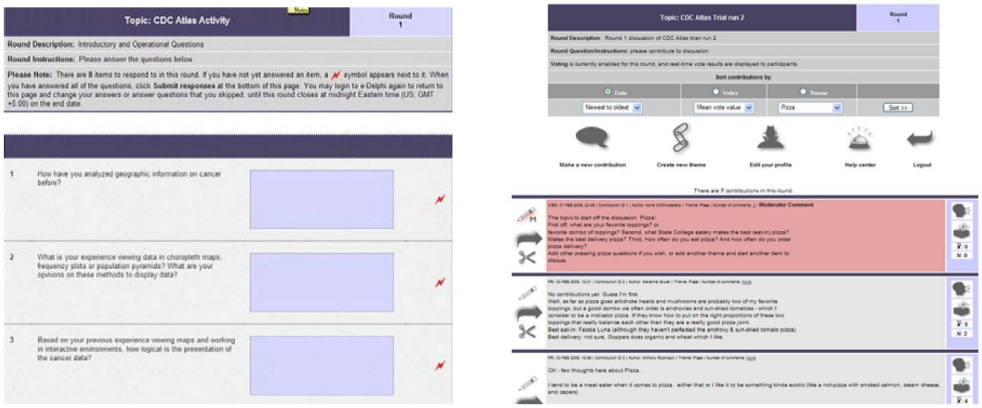

Figure 1: Snapshots from the e-Delphi portal, showing a survey interface at left and discussion interface at right.

Ultimately, the changes we made to PA-CA from this distributed evaluation activity helped ensure that the U.S. Centers for Disease Control used the PA-CA as the model for their own Interactive Cancer Atlas, which launched for public use in 2010. Our distributed evaluation not only provided the feedback we needed to evolve the design of the PA-CA, it also allowed us to obtain this feedback from the best experts we knew, regardless of their location and scheduling constraints. On the flipside, moderating these activities and evolving the e-Delphi platform to support user-centered design activities required more effort on our part than would have been necessary for a more traditional same-place, same-time evaluation.

CASE STUDY: DESIGNING LEARNING TOOLS TO SUPPORT GEOVISUALIZATION IN PUBLIC HEALTH

Our second study to employ distributed methods for conducting user studies focused on the design of a web portal to support learning about geovisualization. In recent years it has become apparent that interactive mapping and spatial analysis tools are underutilized by health researchers and decision-makers due in part to scarce training materials, a small number of examples demonstrating the successful use of geographic visualization in public health contexts, and generally unsatisfactory mechanisms for sharing the visual/statistical results generated by geovisualization (Bhowmick, Griffin et al. 2008). To begin making

progress on these problems, we initiated the development of the Geovisual EXplication (G-EX) Portal (Figure 2), a web-based application designed to connect geovisualization researchers to public health analysts (Robinson, Koua et al. 2007) through the provision of interactive learning materials.

As part of the iterative design and development process for the G-EX Portal, we conducted a needs assessment survey with potential public health end-users. The goal of this study was to shape the design of G-EX tools to support learning about geovisualization in public health. Specifically, we developed a survey to elicit users' current learning habits, their preferred types of learning artifacts, and advice they may have for designing mechanisms to contribute learning artifacts to the G-EX Portal (for details, see Robinson, Roth et al. Submitted). To conduct the survey, we recruited a group of twenty-one public health analysts and researchers from around the United States and asked them to complete the survey through a web-based survey portal called SurveyMonkey (Gordon 2002). Again, the use of a distributed, web-based assessment mechanism made it possible for us to elicit user feedback without costly investments in time and resources to reach each participant in person. Considering the fact that we were seeking feedback to incorporate into initial designs for the G-EX Portal it is likely that without using a distributed method we would have simply not been able to justify the time and resources required to conduct any in-person studies. Instead, we would have reserved those resources for supporting evaluation of the final product.

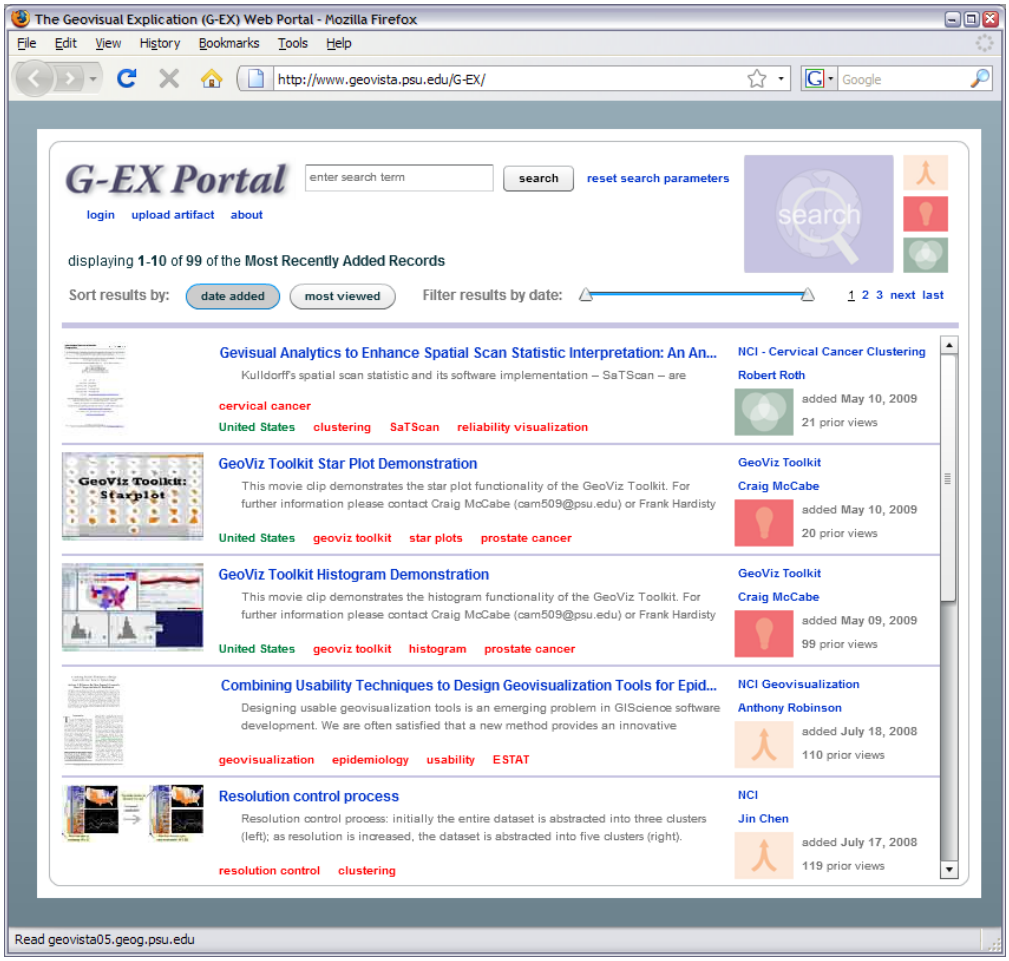

Figure 2: The primary user interface for the G-EX Portal.

Our survey results revealed that participants are seeking a wide range of learning artifacts in terms of their formats (text, video tutorials, etc…) and the topics they cover. Results also indicated that users are willing to create and contribute learning artifacts as well as personal information that would help other users to evaluate the quality and credibility of learning artifacts. Ultimately, what we learned from conducting a distributed, web-based survey to identify user needs was fed directly into the development of an improved prototype G-EX Portal, including a range of new features we would not necessarily had considered had we not had this feedback early on from realistic end-users. While we did not have full control over the survey platform, the commercial tools do provide easy-to-use interfaces for survey creation, distribution, and results analysis, making it very expedient to create, deploy, and interpret the results from a needs assessment survey.

CASE STUDY: SUPPORTING MAP SYMBOL STANDARD DEVELOPMENT

Finally, our third study to employ distributed means for eliciting user feedback focused on the iterative development of map symbol standards. The most typical mechanism by which geographic information is disseminated and consumed is through visual representations of features and their spatial context on maps. One way in which cartographers simplify reality to display features on maps is through the use of graphical symbols. In recent research we have focused on the challenges associated with supporting cartographers who must collaborate to refine, formalize, and standardize their symbols (Robinson, Roth et al. 2010).

Building on the feedback we gathered from a traditional, in-person needs assessment interviews with fourteen mapmakers at the U.S. Department of Homeland Security (for details, see Robinson, Roth et al. Submitted), we designed a distributed, asynchronous symbol standardization process that uses a web-based platform. Our platform, which we call the e-Symbology Portal (Figure 3), is a customized Drupal content management system (www.drupal.org) that allows us to create round-based activities to facilitate an iterative process of map symbol standard refinement. The e-Symbology Portal allows moderators to create multiple rounds of web-hosted activities which can include threaded discussions, polls, and survey questions. Because it is built on a robust content management platform, the e-Symbology Portal allows us to present a diverse range of digital media to participants for them to consider during each round of the standardization process. Additionally, where it is appropriate we can link out to other internet resources (for example, we use the WebSort card sorting tool (Chaparro, Hinkle et al. 2008) as part of our iterative standardization process) from the e-Symbology Portal. In many ways, the e-Symbology Portal represents the next evolution of what we began with the modified e-Delphi portal that we used to help design the Pennsylvania Cancer Atlas.

Figure 3: An example of a poll (with discussion of its results) in the e-Symbology Portal.

The symbol standardization process that the e-Symbology Portal supports is a multi-week, multi-round process, and is facilitated by research team moderators who continually prompt users for feedback, suggest new polls and topics, and help shape each subsequent round to match the unique needs of each organization that is faced with the challenge of standardizing their symbology. This sort of sustained engagement from end users would most likely be impossible to elicit were it not for distributed, web-based tools to allow periodic, asynchronous participation from a team of collaborators.

To test this new standardization process and platform, we have completed a case study with cartographers at DHS (for details, see Robinson, Roth et al. Submitted). This study showed that our process allowed participants to identify a substantial number of improvements on symbol design, symbol definitions, and symbol categories. The approach elicited sustained, iterative engagement despite the collaboration occurring at a distance and in an asynchronous manner, and in a post-study survey our participants indicated that they found the e-Symbology portal and symbol standardization process to be quite usable and useful.

RESEARCH CHALLENGES

Our experiences with these case studies suggest several key research challenges for the further development and application of distributed methods for evaluating spatial technologies.

Develop empirical basis to support the selection and combination of distributed methods for user evaluation of spatial technologies

While some progress in HCI has focused on comparing remote methods to identify their strengths and weaknesses, there must be corresponding progress in the geographic community to understand the utility of different remote methods for evaluating spatial technologies. In our work we have used different combinations of tools to achieve our evaluation goals, but there remains a need to develop evidence-based criteria for the selection of specific remote methods for different types of evaluation goals (formative vs. summative, for example). Furthermore, there is a need for greater empirical guidance with respect to when it makes the most sense to use remote methods instead of in-person methods.

Develop flexible software platforms for conducting user studies of spatial technologies

In the examples outlined above, various open-source and proprietary content management systems were used to support remote user studies. Further progress is needed to develop such platforms so that researchers can assemble components from a palette of available user evaluation tools to create an end-to-end, iterative user evaluation process. Open-source systems like Drupal offer the opportunity to directly integrate common interactive mapping tools and other web-based geographic software, so that the evaluation process can be directly coupled to the tools in question.

Identify new approaches for eliciting high-quality, detailed user feedback at a distance

In our work we have primarily focused on using remote, distributed methods to elicit feedback on interface designs and other formative design activities. To use similar methods to study analytical work with spatial technologies and other complex human behavior, there is a need to ensure that we can capture rich data and descriptions at a distance. For example, recent work by Marsh (2006) suggests that it will be important to develop sophisticated remote methods that allow researchers to observe and characterize exploration and analysis when using highly interactive mapping software. Interaction logging (Kort and de Poot 2005) and eye-tracking (Çöltekin, Heil et al. 2009) are but two of the possible additional technologies that can already be used in remote settings, but we do not yet know the best ways to leverage such methods in remote studies of spatial technologies.

CONCLUSIONS

In this paper we have outlined the need for a deeper research focus on the use of web-based methods for evaluating the usability and utility of spatial technologies. While remote methods for evaluating software have received attention from HCI researchers, so far the topic has received little attention in the geographic community. Here we have begun to elaborate on the intersection between these two areas through reflection on three recent studies to design and evaluation spatial technologies using remote, web-based tools and methods. While there are important tradeoffs to consider (substantial effort to create and moderate remote studies, and generally lower richness in the resultant data), there are many times in which it is advantageous (or sometimes essential) to use remote, asynchronous methods to elicit user feedback. While these examples do not exhaust the diverse range of current methods and approaches for studying the use of spatial technologies, these experiences do allow us to propose an initial set of research challenges for supporting web-based evaluations of spatial technologies. These challenges can help clarify what is and what is not possible using current means for evaluating user needs via the web.

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