SAND2011-4157C

Workshop Proposal: Visualization and the Context of Work - Qualitative Research Methods for Design, Deployment, Evaluation

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ABSTRACT

Information visualization, scientific visualization, and visual analytics (infovis/scivis/VA) technologies are supporting work in a wide range of settings, from scientific research to finance. Perhaps more than any other computer science field, these disciplines have embraced design, with aesthetic and psychological principles influencing and guiding the often-striking representations the field has created. In this workshop, we will explore the social and physical context of work as a third and increasingly important aspect of design for visualization and visual analytics researchers. Qualitative research methods are particularly well suited to this challenge: for example, ethnography is an observational methodology that is inherently oriented toward the careful exploration of context. However, few computer scientists receive training in these methods and are understandably unsure how to employ them to support their research or design goals. In this half-day workshop, presenters from computer science, social science, and design will discuss case studies describing practical approaches to the study of context, including field study methods and theoretical framings that support research, design, deployment, and evaluation of visual analytics and visualization technologies.

KEYWORDS: Human computer interaction, Human factors, Design Methodology, Visualization

INDEX TERMS: I.6.1 [Simulation, Modeling and Visualization]: Visualization systems and software, K.4.3 [Computers and Society] - Social Issues - Organizational Impacts; Computer Supported Collaborative Work; Deployment, Usage Experience

1 INTRODUCTION

As visualization and visual analytics become intrinsic to disciplines as diverse as science, business, engineering, education, and government, we are becoming increasingly aware of the influence of domain specific constraints on visual analysis. As the increasing size and complexity of empirical and simulation data strains the expressive capacity of traditional visual metaphors and analytic frameworks, an understanding of how prospective users think of their work, technology, and community can be a valuable source of new representations and design ideas. Adding interactivity to visualizations places additional demands on designers to understand the activities and collaborative processes of the intended user community.

Qualitative research methods, such as ethnography, have demonstrated their ability to improve the design of software and other artifacts by giving researchers both formal data and personal experience of a target user community. When combined with appropriate theories and analytic tools, this can provide a deeper understanding of user needs and constraints than traditional approaches to requirements gathering. In particular, ethnography and other qualitative research methods can give unique insights into the visual languages, metaphors, interpretive strategies, and collaborative practices of a particular user community. In this half-day workshop, we will explore the benefits, limitations, and challenges of incorporating qualitative research methods in the design, deployment, and evaluation of visualization, and visual analytics technologies.

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2 VISUALIZATION, TECHNOLOGY, CONTEXT

This workshop addresses a growing need for theories and methodologies to bridge the gap between technology designers and stakeholder communities in visual analytics and visualization design and evaluation. This is not unique to infovis/scivis/VA: it plagues many technology projects, and persists despite the fact that computer scientists and software engineers have long recognized human factors as critical to the development of usable, useful, and adoptable technology [1-3]. Visual analytics and visualization researchers draw heavily on perceptual psychology and cognitive science to develop visual vocabularies that support human problem solving [4, 5], but this emphasis on presenting information at the *individual* level has come at the expense of understanding the critical role of social, organizational, and material *context* in designing effective visualization technologies. Ethnography and other qualitative research methods developed in social science provide a systematic way of studying these contextual factors [6-10].

2.1 Challenges in Visualization Technology Design and Evaluation

There is a fundamental tension between computer science's aim of creating algorithms that can be applied to general classes of problems, and design's goal of meeting the unique needs of user groups. Infovis/scivis/VA emphasizes this tension, because visual representations of information - not just computational visualization and visual analytics, but *all* forms of visual representation - support such a wide range of activities, from pattern recognition to communication, across all contexts in which humans interact with each other and the world around them.

Informatics visualizations in fields from textual analytics to genetic mapping provide a compelling example of this tension between algorithmic generality and the contextual constraints of a specific user community. Although clustering, network diagrams, hierarchies, and other techniques commonly used in informatics visualization are general, user interpretations of them can vary widely. This can even lead to misinterpretations: compelling graphical layouts may lead naïve users mistakenly to attribute structural significance to "relationships" for which supporting data are sparse or error-prone [11]. This tension is evident in scientific visualization, where the growing importance of extremely large (peta/exascale) simulations and data sets requires abstraction or filtering of the data before presentation. Doing so effectively requires understanding how a particular scientific community will approach data analysis. Animations, plots, and other traditional visualizations may be unable to express the

complex interactions found in multi-scale, multi-physics simulations. Understanding the user community's problem domain and analytic practices may help develop new visual metaphors and representation techniques. Uncertainty quantification requires analysis of large ensemble data sets, and such analyses further reflect the particular goals of a user community. Understanding the specific goals, interests, and analytic practices of the user community can not only improve user interface and interaction design, but also may inform mathematical research and algorithmic design at surprisingly deep levels.

The most compelling drivers for qualitative research methods come from the demands of moving visualization and visual analytics technologies out of the research laboratory into high-consequence decision support applications in government, health, military, and commercial applications. The influence of organizational goals and structures, legal and regulatory requirements, risk profiles, legacy technologies, funding constraints, and organizational history raise complexities for application developers that may not be relevant in a research setting. A lack of alignment between users and developers can be subtle, difficult to recognize in early stages of work, but painful in later stages when it is difficult to change an application. Understanding these constraints early in design, in ways that are directly relevant to user needs can mean the difference between a successful and failed application of a promising technology.

2.2 Ethnographic Methods for Design

For over sixty years, researchers in government laboratories, academic departments and high-technology industries have been applying social science research (particularly psychology) to the design of technology for human use. Over the past two decades, as computing technologies have assumed an increasingly significant role in daily life, the field of usability engineering has become a well-established profession. Practitioners can choose from a plethora of research methods to address design, adoption, and evaluation challenges, from cognitive task analysis to focus groups to eye tracking studies.

Ethnographic field methods have become an important component of the usability research toolkit. Ethnography is the hallmark research paradigm of cultural anthropology, and designates both a methodology (participant-observation) and research product (typically a monograph). In the 1980s, as cultural anthropology was undergoing a "repatriation" in which Western-trained anthropologists began to focus attention on field sites in the United States and Western Europe, a handful of anthropologists pursued field studies in high-technology settings such as Xerox PARC. Their striking findings captured the attention of both design engineers and corporate business managers, and established design ethnography as a research practice [12-14].

Ethnographic studies can generate rich depictions of user communities, but what constitutes "good ethnography" is not well understood. Computer scientists and software engineers who are superficially familiar with ethnography may view it as a risky investment of resources. Many perceive the methodology as a time-consuming and expensive research approach that requires trained experts whose cost can be difficult to justify - particularly when project stakeholders lack familiarity with ergonomics, human factors, or usability research. One reaction to this has been to deny the importance of rigorous methods and a systematic theoretical framework to ethnographic research and argue for casual, unstructured approaches to user studies. This approach, often referred to as "deep hanging out," is appealing to some, but can lead to superficial or misguided characterizations of complex human communities.

When properly designed, implemented, and documented, ethnographic research can provide invaluable detail about contextual factors that are impossible to capture using traditional "consumer study" methods, such as focus groups, interviews, or task analyses. Moreover, clear and cogent theoretical frameworks emerging from fields such as Interaction Design, Distributed Cognition, Activity Theory, and Situated Cognition provide guidance for the design, development, implementation, and products of ethnographic studies. The scientific visualization, information visualization and visual analytics communities can derive tremendous benefit from incorporating these theoretical frameworks and ethnographic techniques into a wide range of design, development, and evaluation challenges.

2.3 Computing, Visualization, Users and Context

Visualization is ultimately about presenting information to human beings in honest, faithful, and ultimately beneficial ways, and there is a long history of interaction between infovis/scivis/VA and user-oriented design. Indeed, several visualization researchers played founding roles in the field of human-computer interaction, just as human cognition and problem-solving have provided at least normative orienting goals for the computational visualization community [3-5, 15-17]. It is surprising, then, that "human factors" is a relatively new research problem for visualization designers [18]. In particular, as visualization technologies have moved from research laboratories into commercial and government sectors, the field has come to recognize the importance of usability, utility, adoptability, and *context-of-use*. For example, in 2004 Amar and Stasko argued that simply "showing the data" fails to address the analytic complexities introduced by a user community's responsibilities and stakeholder relationships, describe as the "analytic gaps" of worldview and rationale [19, 20]. Recognizing the complexity of this terrain, visualization researchers are organizing forums (e.g., the Visual Analytics Community/ VAC Consortium), workshops (BELIV'06, '08, and '10), and even interdisciplinary research programs (the SCIENCE Lab at Simon Fraser University), to examine the intersection of human cognition, organizational workflows, and visualization technology in a range of settings.

Several researchers have suggested that ethnographic field methods may play an important role in designing, deploying, and evaluating information visualization and visual analytics technologies [21]. For example, Shneiderman and Plaisant pointed out that the kinds of creative, open-ended, collaborative and long-term problems supported by visualization technologies are not well suited to traditional human-computer interaction evaluation methods. They suggested that ethnographic field methods could play an important role in designing and implementing multi-dimensional, in-depth, long-term case study evaluations, or "MILCs" [10]. More recently, Munzner proposed an ethnographically-oriented research framework for studying user domains and workflows, to ensure that developers are providing users with "valid" tools: i.e., the right algorithms and supporting software for the right problems [6].

As the visualization community continues to incorporate contextual considerations into technology research and development, ethnographic and other qualitative research methods are likely to play an important role in the evolution of both technologies and techniques. However, ethnographers who understand the unique dimensions of information visualization, scientific visualization, and/or visual analytics technologies are rare, and few visualization researchers have training in either qualitative research methods or ethnographic techniques. This creates an unfortunate barrier to the adoption of ethnographic methods, in spite of their potential to contribute to a wide range of visualization research challenges.

2.4 Workshop goals and outcomes

This workshop will provide visualization researchers with an introduction to ethnographic field methods, and an overview of theoretical frameworks that can be used to guide ethnographic study design and data collection. We will illustrate the benefits and challenges of incorporating ethnographic field methods into technology design and development through case studies drawn from experience. Our goals are to communicate the value of ethnography and other qualitative research methods to infovis/sciviz/VA research and application development, to give them an understanding of how to integrate qualitative research into a software R&D effort, to prepare them to work effectively with ethnographers and other user researchers, and to help interested attendees to start the longer process of learning these methods themselves.

3 PROPOSED WORKSHOP

In this section we will specify the technical scope of the workshop, the challenges and benefits in presenting ethnographic methods to the visualization community, the proposed structure of the workshop and how it addresses these needs, and the recruitment of presenters for the material.

3.1 Potential Benefits and Major Challenges

3.1.1 Benefits

Ethnography and other forms of qualitative research can usefully identify a broad range of contextual elements that bear on work activities and analytic practices, by characterizing organizational, technical, cultural, economic, and other contextual elements that impact adoption issues, and by specifying how visualizations support different classes of problem solving activities. Qualitative methods can also contribute to research into the development, use, and expressive ability of visual metaphors and semiotic conventions employed in a range of analytic contexts, helping researchers identify novel approaches to the visualization and visual analysis of complex data. These methods can also make contributions to interdisciplinary research in areas such as the relationship between culture and visual analysis, or even in the development of visualizations to inform the social sciences from which ethnography emerged.

3.1.2 Challenges

As with any interdisciplinary effort, introducing ethnography and other qualitative research methods into visualization and visual analytics raises unique challenges this workshop must address. Both ethnography and visualization depend on rich, specialized languages to improve the efficiency and precision of communication within each field, but these "jargons" can be obstacles to communication across disciplines. Incorporating ethnographic methods with research on human visual systems, perception, cognitive psychology raises novel and significant research challenges. The longer time commitments required for ethnographic studies can conflict with the short time frames found in computer science R&D. Practical concerns facing applications developers include the difficulty of finding people with sufficient knowledge of both visualization and ethnography (a problem this workshop hopes to address), the time and labor intensive nature of ethnographic work, and the difficulties of adapting ethnographic methods to visual design. Integrating qualitative research into software development methods is another often-cited issue that must be addressed.

This workshop includes presenters from diverse backgrounds who have worked at the intersection of the computational and social sciences, with an emphasis on visualization. Case studies will provide practical examples of both successful and failed efforts, while a concluding panel discussion will engage the audience and participants in a broader dialogue about the role of qualitative research in the evolution of visualization technology.

3.2 Workshop Structure and Goals

We propose a ½ day workshop. Because of the novelty of our subject matter, the difficulties outlined above, and the potential to have a large number of attendees, we are planning a highly structured approach. The proposed workshop agenda is:

1. **Problem Statement** (20 minutes/McNamara & Stubblefield). This will outline the potential benefits of introducing ethnographic methods into visualization R&D, the basic structure of qualitative research methods and theoretical frameworks, and the challenges of this interdisciplinary approach.
2. **Theoretical Frameworks** (20 minutes/Stubblefield). Stubblefield will present representative theories used in interpreting ethnographic observations. The discussion will emphasize their common threads and application to real design and development situations.
3. **Ethnographic Methods** (20 minutes/McNamara). McNamara will provide a basic overview of ethnographic study design, implementation, documentation and supporting qualitative methods.
4. **Case Studies** (60 Minutes/Speakers to be selected). This will consist of three case studies in which ethnographic methods were applied to actual research and applications development efforts, and will present both effective practices and those that did not work well.
5. **Panel Discussion** (60 Minutes/Panelists to be selected). This will be a moderated discussion aimed at bringing out differing opinions on critical issues in applying ethnographic methods to visualization R&D.
6. **Audience Q&A** (45 Minutes/Panelists and presenters)

Because we expect that many visualization researchers will be interested in learning more about ethnography, we will supplement our workshop with a handout that includes an extensive annotated bibliography.

3.2.1 Recruiting Participants

We plan to recruit participants from both the design ethnography and the visualization communities, using group e-mail lists and our personal networks to publicize the workshop. We are seeking participants to present case studies and to participate in the panel discussions. For each, we will seek a balance between ethnographers who have worked with visualization projects, and visualization researchers who have conducted ethnographic fieldwork. Appropriate contact lists include participants from the previous BELIV workshops as well as the Visual Analytics Consortium, and the AnthroDesign community, a mailing list and interest group that promotes ethnographic practice for technology development.

4 CONCLUSION

This workshop will benefit both scientists in all subfields of visualization research and practitioners involved in designing and developing practical applications of visualization and visual analytics technologies. All too often, promising technologies fail to secure use, not because of any deficiency in the technology itself, but because the implementation failed to present the technology in ways that fit the work practices, collaboration conventions, interpretive models, problems, legacy infrastructure, or goals of the target user community.

Conversations with colleagues in the visualization community indicate high interest in learning about ethnographic methods. To support this interest, within six weeks of the workshop we will develop a workshop proceedings that includes the presenters' materials and a summary of the workshop discussions. To speed dissemination, we will publish this as a Sandia National Laboratories report and provide public electronica access via our Sandia publications website, and hopefully the Visual Analytics Community (VAC). We will use the workshop materials to develop a journal article examining the intersection of ethnography and visualization, for publication in one of the visualization community's flagship journals.

5 About the Organizers

Laura A. McNamara is a Principal Member of Technical Staff in the Exploratory Simulation Technologies Organization at Sandia National Laboratories and holds a PhD in cultural anthropology. She conducts field studies in national security environments to assess barriers and opportunities for new technology development and adoption. McNamara has worked with nuclear weapon experts, intelligence analysts, and cybersecurity experts, focusing on issues of expert knowledge elicitation and representation, verification and validation in computational social science, uncertainty quantification, user centered design strategies, innovation adoption, and software evaluation.

William Stubblefield is a Principal Member of Technical Staff in the Scalable Analysis and Visualization Group at Sandia National Laboratories. He began his computer science career in Artificial Intelligence and Cognitive Science, writing his PhD dissertation on a computational model of analogical reasoning. He shifted his professional interests to Human-Computer Interaction after an unfortunate series of encounters with reality made him aware of the difficulty of designing software that people would actually use. He is currently working on the cognitive dimensions of complex computer simulations and large-scale data analysis. For additional information see: http://wmstubblefield.com/.

McNamara and Stubblefield have over twenty-five years of combined experience in performing qualitative research in the deeply technical environment of a national laboratory, and have belonged to a visualization group for the last several years. This has given us an understanding of the needs, concerns, and assumptions of both visualization developers and their users. Both authors have experience in presenting ideas from design and social science to people trained in the physical sciences and engineering, and have learned how to avoid jargon in our theoretical and methodological discussions.

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