Public visualization displays of citizen data: Design, impact and implications

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ABSTRACT

In this paper we propose citizen-driven, public data visualization as a tool to support social and civic purposes in public spaces. We argue for the potential of this approach, motivating it with recent trends and developments in the areas of information visualization, urban computing, and urban screens, and we layout a transdisciplinary research approach and methodology. Through three studies approaching our research goal from design, empirical, and reflective perspectives, we show how visualization interfaces, situated in public spaces can improve perception, and lead to sustained behavior change; can increase social awareness and discourse; and can influence meaningful participation and a range of social interactions related to locally relevant topics. We conclude by discussing implications for the design, use and evaluation of citizen-driven public visualization as a tool increase public awareness, participation and discourse.

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1. Introduction

The constant development of ubiquitous computing has enabled the expanded integration of computational, sensing and display technologies into everyday public settings and lifestyles beyond the workplace, including the spaces where we meet, study, play and relax (Greenfield and Shepard, 2007). The ability to measure, monitor and track the digital traces people leave as they go about their daily lives has turned into true capital for an increasing number of urban stakeholders. While global technology companies are offering 'smart-city-in-a-box' solutions, bottom-up structures and individuals advocate active engagement with urban data through DIY urbanism and citizen hactivism. Yet, it is still unclear how this urban data, and the technologies able to acquire and display it, can be of true value to its the citizens who generate it (Townsend et al., 2010). The combination of data visualization as a means to represent citizen-driven data in attractive and insightful ways, with ubiquitous technologies for displaying, sensing and interacting, could potentially make us more informed and engaged citizens (Foth et al., 2011).

This paper describes a design and empirical inquiry into the potential of citizen-driven, public data visualization for social and civic purposes. Building on trends and developments in the fields of information visualization, urban computing, and urban screens and media architecture, we explore how data visualization, display technology and different data-sensing mechanisms can be combined to promote awareness, discussion and participation. Our research is based on an interdisciplinary approach combining methods from design and computer science, with qualitative methods drawn from ethnography. Inspired by two preliminary design studies into public data visualization, we present the design and in-the-wild evaluation of three data-driven visualization installations. These three visualizations approach the overarching objective from the perspectives of (1) inciting and sustaining behavior change, (2) supporting reflection and discussion, and (3) influencing participation and social interaction. In-the-wild deployments in several distinct public settings have provided insights into how people engage with visualization of data originating from themselves, and how data representation and feedback modalities, the interface and interaction design, and the physical and contextual

settings influence this engagement. We conclude by discussing the challenges for the design, use and evaluation of public visualization of citizen-data as a tool to increase public awareness and discourse on socially relevant topics.

2. Background and motivation

The scope of this research is defined by the overlap between information visualization, urban computing, and urban screens and media architecture (Fig. 1). While drawing from and contributing to these three areas, each of them assumes distinct roles in our research:

- *Information visualization* is our main *source* for research and design. We are motivated by the potential of recent developments in the field, which highlight ambient, social and artistic purposes of visualization. We are interested in exploring visualization techniques adapted to personally meaningful data sources, and to the social groups and places people live and play in.
- *Urban computing* provides the conceptual and technological *backdrop* of this research. Rather than focusing on the potentials of ubicomp technologies to improve efficiency and productivity through computational prediction, monitoring and optimization, we adopt a proactive human perspective, which considers ubicomp technologies that can support curiosity, creativity, insight and meaningful action.
- *Urban screens and media architecture* constitute the *medium*, whose particular characteristics and potentials motivate and drive this research.

In the following, we motivate our work by detailing how it builds upon relevant trends and developments in these research areas.

2.1. Information visualization

Research on information visualization is concerned with the creation and study of interactive and graphical representations intended to make sense of data (Dörk et al., 2009). The most common definition of information visualization, that has been agreed upon is *"the use of computers to interactively amplify cognition, using visual representations"* (Card et al., 1999).

The strength of information visualization lies in supporting the advanced characteristics of the human visual system, in particular its ability for pattern recognition, discerning trends and relationships, and identifying outliers (Ware, 2010). Accordingly, visual representations of information can aid memory, make abstract concepts visible, support

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problem solving and decision-making, and make the analysis of large datasets more efficient (Myatt and Johnson, 2011). With the arrival of computers, computer graphics and the Internet, information visualization has developed drastically. Advanced technological tools enable faster statistical analyses and data mining, allow the visualization of complex and multivariate datasets, and support interactivity for exploration and in-depth analysis.

Since the establishment of 'infoviz' as a dedicated research community, information visualization researchers have created and studied a wide range of visualization techniques aimed to support the analysis of complex datasets (e.g. Inselberg and Dimsdale, 1991; Johnson and Shneiderman, 1991; Herman et al., 2000). For most of these advances in information visualization, the target audience has been a population of expert users, who possess the knowledge and experience in analyzing problems in specific domains, such as finance, market research, journalism and science. The major purpose of information visualization tools has been to help professional users explore data, generate, refine and test hypotheses, and ultimately to produce insight in goal-oriented, work situations (Pousman et al., 2007).

In contrast, more recent developments highlight ambient, artistic and social purposes of information visualization beyond professional domains, audiences, and environments. In the following, we will introduce these perspectives and illustrate the characteristics that inform our work.

2.1.1. Ambient visualization

Ambient visualizations (Pousman and Stasko, 2006) are information systems that provide abstract depictions of invisible dynamic processes, such as changes in weather, stock, currency or the amount of human presence or activity in a building, and are located in peripheral locations of everyday physical settings (Rogers et al., 2010). For instance, the Ambient Orb[1] maps stock (or weather) data into the color of a glowing orb, fading slowly from green when stocks are rising to red when stocks are dropping. Ambient visualization aims at providing visually appealing, unobtrusive, and physical interfaces to invisible data streams.

The idea of raising the awareness of people by placing dynamic representations of data in the immediate and public physical surroundings is one of the major concepts that inform the design studies conducted within our research. Furthermore, the concepts of ambience, esthetics, and seamless environmental integration are specifically explored in our initial Studies 1–3 (see 3.3 *Overview of studies*).

2.1.2. Social visualization

Social visualization focuses on enriching electronic social communication by making its rich and salient qualities visible in easily accessible and understandable ways (Donath et al., 1999). Recent initiatives in this direction have shifted towards democratizing the power of visualization and making its features accessible and usable for the public at large. For instance, *Many Eyes* is an online community platform that allows Web users to upload their data sets, choose visualizations and discuss them with other community members (Viégas et al., 2007). In this way, social visualization offers non-experts the chance to increase their understanding of complex information by the power of collective and collaborative efforts (Viégas et al., 2007). Research efforts have also demonstrated how people can be encouraged to create public visualizations for communicative and participative purposes, which by themselves can even provoke sufficient motivation for spurring significant social activities (Danis et al., 2008; Heer et al., 2008; Gilbert and Karahalios, 2009).

These developments around the collective and collaborative exploration of personally meaningful data, combined with the idea
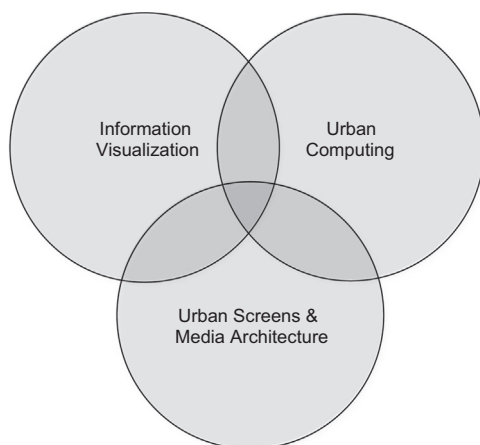
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[1] http://www.ambientdevices.com/.