Making three Cases for Casual Geovisualizations on Interactive Surfaces

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ABSTRACT
In this paper, we present three case studies on visualizing spatiotemporal data on interactive tabletops and surfaces for casual use. While there is a growing interest among citizens to make sense of their social community and urban environment, most existing geovisualization tools have been designed for experts such as planners and analysts. We introduce situation-specific visualization systems that were particularly designed for public exhibitions to balance powerful data exploration methods with inviting accessibility for laypeople. Finally, we discuss some of the lessons learned regarding people's interest, interaction conventions, and information aesthetics.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces

Author Keywords
Geovisualization; casual visualization; interactive tabletops.

INTRODUCTION
While geovisualization is an established area of research and practice concerned with the interactive exploration of geo-referenced data [11], visualizations are often aimed only at experts analyzing the data, and therefore tend to be sophisticated and challenging for laypeople to grasp [1]. As data related to people's surrounding increasingly become interwoven into people's life, visualizing such data for casual exploration is vital. We investigate how to best facilitate exploring and understanding such data sets for wider audience with varying visualization and data literacy. This question entails to explore effective ways of visualizing spatio-temporal data in interactive ways to reveal patterns, relationships, and trends, and to support different stakeholders gaining insights while engaging and attracting casual users in semi-public settings.

RELATED WORK
Information Visualization can benefit from interactive tabletops and surfaces, both by leveraging the dimension of large displays, as well as the usability of natural interaction mechanisms [3]. This can lead to more effective and engaging ways to employ visualizations [8]. Geovisualizations and interactive maps are common applications on large scale interactive displays. Since decades, large, high-resolution displays have been used for geographic information systems [4], or urban planning [9]. In a recent survey on visualization on ITS, maps were frequently used to represent information as they work especially well on large displays [7]. Traditional information visualization targets an audience of experts with extensive knowledge and skills in a domain, and supports them analyzing specific problems. In contrast, casual information visualization targets different audiences, and entails the use of "computer mediated tools to depict personally meaningful information in visual ways" [16]. While the purpose of visualization generally are insights, casual visualization also has additional purposes: to raise awareness, to fuel discussions, or to create a pleasant user experience [17]. Over the years, casual information visualization systems on interactive tabletops and surfaces have been designed, and put to use in museums (e.g. [6, 15]), libraries (e.g. [18]), and urban public spaces (e.g. [19]). By placing novel visualization systems on interactive surfaces in public settings may open up the use of visualizations to a broader audience beyond the traditional user group of data analysis experts [8].

In our work, we investigate the use of geovisualizations on interactive tabletops for casual use with multiple case studies tailored for specific scenarios.

APPROACH / METHODOLOGY
Our research approach was guided by an explorative methodology. Within this work, we designed and evaluated three case studies from different domains. For each, we followed principles from a human-centered design [5]. With every case study we investigated its domain while following the shared main goal of enabling a casual exploration of geo-referenced data on a large interactive screen displayed in semi-public spaces. We traversed the full design process of domain analysis, design requirements, prototype development, and evaluation in order to approach the research field in a holistic approach essential for real world use. We publicly exhibited visualization systems to large audiences in order to observe how people

would interact with them in real world settings. We complemented these demonstrations with other established evaluation methods when necessary.

All case studies had in common that the knowledge inherent in the data was relevant to non-experts for their everyday life. However, each data set was different in its specifics, and exemplified different aspects of tempo-spatial data. These ranged from classic geo-spatial data such as information on buildings and places, to geo-referenced social network data, to mobility data based both on authoritative data sources (timetables), as well as sensors and smart phones (passenger data).

THREE CASE STUDIES

In the case studies, we explored how to visualize a) faceted data of urban redevelopment for casual exploration of citizens and urban planners, b) collaboration between research institutions for casual exploration of scientists in a conference setting, and c) public transit data for casual exploration of public transit experts and citizens. Besides these domain-specific design goals, with each case study we had a specific question we addressed in the visualization, yet are applicable for casual geovisualizations in general:

- How to facilitate interactive exploration of faceted data for casual users without providing complex user interfaces?
- How to support exploring personal relevant data in such ways to facilitate a social space to discuss insights with others?
- How to provide access to multiple perspectives into complex tempospatial data for casual users?

To illustrate how we addressed these questions, we briefly summarize the case studies along their domains, methods, and findings.

Case Study 1: Venice Unfolding

Figure 1. Tangible object to explore faceted architectural data.

What: Venice Unfolding [13] is a visualization of urban redevelopment projects, with tangible interactions to support faceted browsing of architectural metadata. It aims to invite citizens and urban planners to explore multi-variate data (e.g. construction year, material, function) within the Venetian redevelopment process.

How: On a large interactive tabletop, projects and their relations are shown on a map. A polyhedron acts as physical artifact allowing users to interact with the visualization in tangible way (Fig. 1).

Main Contribution: Design and evaluation of a novel interaction method consisting of a polyhedron people can tilt to filter and search through the taxonomy, place to select specific projects, and rotate to browse through a project's background information.

Case Study 2: Muse

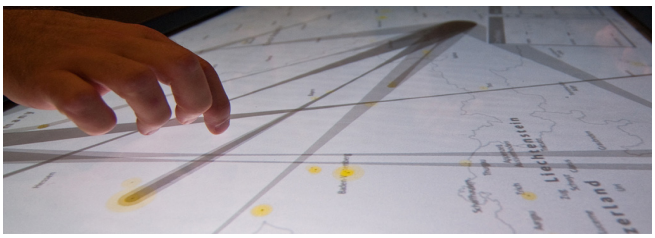

Figure 2. Map showing relations between scientific institutions.

What: Muse [12] is a tabletop visualization of collaborations between research institutions. It is intended to be used at scientific conferences and aims to engage audiences to explore their professional network, as well as to act as casual background to initiate discussions on future collaboration.

How: It visualizes scientific connections between institutions based on co-authorship, and shows the places and their relations on an interactive map (Fig. 2). Multiple in-situ demonstrations and in-the-wild studies with conference attendees.

Main Contribution: How to harvest and enrich metadata from data repositories in ways to show spatial relationships. A couple of best-practices and guidelines extracted from a multi-prototype iterative design process.

Case Study 3: Touching Transport

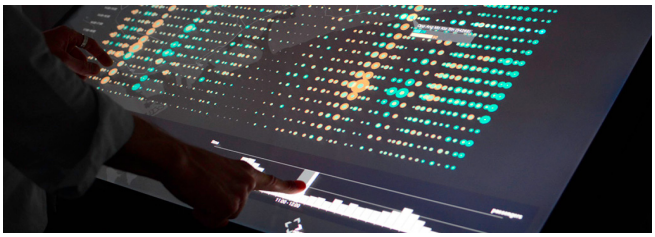

Figure 3. Time-series showing bus passengers for a day.

What: Touching Transport [14] is a multitouch visualization of public transit network. It supports the exploration and understanding of complex tempo-spatial data for experts and non-experts.

How: The system provides multiple perspectives of the data and consists of three interactive visualization modes conveying tempo-spatial patterns as map, arc view, and time-series (Fig. 3).

Main Contribution: Design and in-situ demonstration of tabletop visualization system. Lab study informed by in-situ observations, investigating how our system supports gathering insights for three different user groups (experts, citizens, and non as control).

DISCUSSION

Based on the design and the contributions of the case studies we identify and discuss some general lessons learned when

constructing geovisualization for casual use on interactive tabletops.

Interest: Attract users in semi-public settings

In our publications [13, 12, 14], we have described how we designed our systems in ways casual users found it fun to use, and interacted with the information visualizations on large tabletops installed in semi-public spaces. In Venice Unfolding, we provided novel interactivity with a compelling looking tangible object. This polyhedron enables playful exploration of multi-faceted data. In Muse, we managed to attract conference attendees to explore the data by providing personal relevant data in established visualizations. In Touching Transport, a highly polished visualization style as well as an animation cycling through the day when no one was interacting with the table for a while drew in visitors in an exhibition.

In casual settings, users first have to be attracted to the system in order for them to start exploring the geospatial data. Each prototype provided at least one large map visualization, which most people were likely to be already accustomed to, both in terms of understanding the data (e.g. their city's transit network) as well as the interaction possibilities (e.g. pinch and zoom). In the map views, we reduced visual complexity by balancing level of details in the base maps between a simple visual style (to not overwhelm users with complexity, and to not interfere with visualized data atop), and sufficient geographical features (to allow viewers to understand geo context and to orient themselves).

Visualization systems in semi-public spaces should invite users through curiosity and aesthetics so they will be attracted to the system, start playing with it, and finally explore the visualized data. The systems should be designed in ways to engage such audiences to keep exploring the system, and to facilitate serendipitous discovery.

Conventions: Intuitive multitouch interactions

While demonstrating our case studies in-situ, we observed people struggling with a variety of interactions. Users tried to tap the menu element in Venice Unfolding, while our prototype only offered moving the polyhedron towards the element for selecting it. In the first Muse prototype, people tried to tap an item from the Exploding Menu, while one had to tap, slide, and release to select an item. In Touching Transport, users tapped on a row in the time series view, directly, instead of using the time range slider to select that specific time range. While each implemented interaction pattern had deliberate reasons, we learned that basic tapping interactions works best for an audience of casual users. We suggest to provide multiple ways of achieving the same task, and offer simple interaction methods while also including more advanced interaction techniques to be discovered.

Overall, we learned that casual visualizations on tabletops should provide simple multitouch interactions. Our design decision to focus on self-explanatory interaction patterns and avoid complex gestures helped users to explore the data set. People encountered few problems with the touch interactions and were able to pan the map and tap to select stops. We are confident that – due to the wide-spread dissemination of smartphones and tablet computers – basic touch gestures are well-known nowadays, and can be deployed for audiences in semi-public spaces.

Aesthetics: Minimalism and Fluidity

Chen included aesthetics as one of the top ten unsolved problems in information visualization, and stated that it is important to investigate how aesthetics affects insights, and how these two goals "could sustain insightful and visually appealing information visualization" [2].

In our case studies, visual and interface design were guided by principles of information aesthetics [10], aiming to combine accurate data representation with easy-to-use interactivity. Besides the visual form, aesthetics concern aspects such as originality, innovation, and further subjective factors comprising the user experience [20]. In order to design visualization systems easily understood and enjoyed by the users, we strove for an attractive and minimalistic visual style. Especially concerning the interaction aspect of visualization the notion of fluidity proved vary valuable, including the use of animated transitions, the immediate response of the system, the use of direct interactions, and continuous exploration possibilities [3].

In our case studies we explicitly designed towards minimalistic aesthetics and fluid interactivity. In Venice Unfolding we integrated faceted browsing with a map display in a single unified view. In the iterative process of designing Muse, we went from coordinated multiple views to single views due to user's feedback. Touching Transport has three distinct views, but shows one visualization at a time, rather than all three simultaneously, in order to lower visual complexity for casual users.

It is important to value user's satisfaction in visualizations for casual use. Participants in our Venice Unfolding study found the visualization system appealing, conference users in our demonstrations of Muse liked the system and found it aesthetically pleasing. With Muse and Touching Transport, we have demonstrated that visitors in semi-public spaces were attracted to the visualizations, and shown with Touching Transport that this enables lay people as well as experts to explore the data.

CONCLUSION

Through our case studies, we have learned that geovisualizations for tabletops can attract interest of passers-by and enable them exploring the data sets by showing visually pleasing und inviting visualizations, while also providing access to more complex data aspects. We have demonstrated that aesthetics and functionality work together, and support casual users to both enjoy and utilize the systems.

The design and description of our case studies, the explanation of our methodologies, and the discussion of our findings are important parts of our contribution. Moreover, the developed prototypes themselves also act as artifacts which encapsulate our design decisions, and thus embody parts of our research results.

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