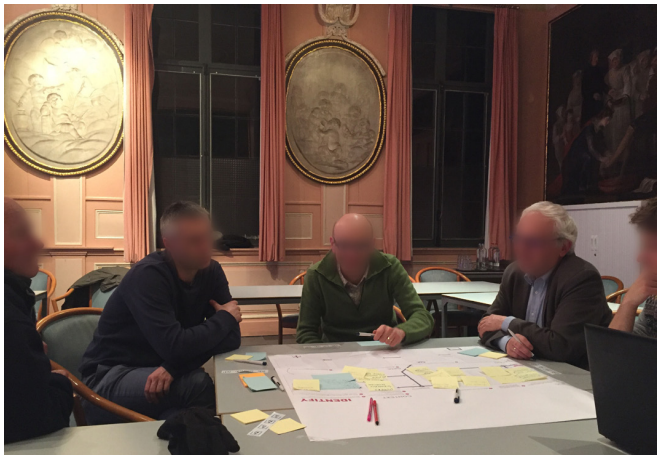

Figure 1: Phase 1 of the CDK methodology: workshop with engaged citizens identifying a target audience, location, context and data (sources).

The outcome of the workshops deployed in the city park. "Are you concerned about air quality in Leuven? Vote here!", in Dutch.

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CITIZEN DIALOGUE KIT:
THE SITUATED VISUALIZATION OF OPEN AND CITIZEN SCIENCE DATA ON PUBLIC DISPLAYS

ABSTRACT

In this paper we introduce our ongoing research on how to leverage the visualization of open and citizen science data within public space to inform and engage citizens. We developed an open-source toolkit, coined "Citizen Dialogue Kit" that is able to convey timely data visualizations on a set of interactive, wirelessly networked displays that can be freely positioned in urban space. The toolkit consists of a participative methodology to help guide the choice of the data and the design of its visualization, a set of off-the-shelf hardware components, and custom-made open source software that controls the whole system. We summarize the design of the toolkit and its initial deployment, and conclude by discussing implications for urban visualization.

Keywords: urban visualization, public displays, public visualization, situated visualization, civic technology, smart cities, participation

1. INTRODUCTION AND PURPOSE

Due to how public decisions are increasingly initiated from bottom-up demands yet often grounded in data-driven evidence, citizens are becoming active data collectors to advocate for local changes. Popular tools such as the Smart Citizen Kit [1] or Air Quality Egg [2] have opened the door for citizens to gather data to hopefully support the, often hyperlocal, causes they care about. However, often relevant data that might support their goals is stored on online platforms, failing to reach, inform or engage those in the community. As such, data that aims to capture the situation of a space, is almost never fed back to those that can influence that situation. While several toolkits exist to collect data and use citizen science techniques to build communities for change [3], none seem to support the situated visualization of the collected data.

In this paper, we describe our ongoing work to develop and evaluate a toolkit for situated urban visualization [4] aimed at conveying citizen science and open data in context.

The "Citizen Dialogue Kit" (CDK) has two objectives: (1) to

enable organizations and bottom-up initiatives to present locally relevant data within its physical and sociocultural context, and (2) to enable passers-by to (re)act upon this information and start dialogs. We believe data is most relevant in its context and aim for anyone to be able to encounter it in opportunistic ways without common technical barriers such as QR codes or website URLs. Previous research has demonstrated that situated visualization [5] can broaden and facilitate participation [6] and that contextually located displays can facilitate knowledge sharing in a community [7]. The toolkit includes an interactive polling functionality alongside the urban visualization to potentially engage onlookers [8] and collect their opinions that might be based on the displayed data and thus become part of the dialog.

2. BACKGROUND

Public displays and situated technologies enable a potential to inform and engage citizens about hyperlocal issues through representations of open data from civic platforms and citizen science [1], as well as through interactive polling [8-10]. It offers an opportunity to underline personal links to local issues [11]. Our previous research on urban visualization [4] has already highlighted the use of narrative techniques in visualization [12] to increase personal relevance and aide insight generation on public displays [13]. We have emphasized the impact of contextual clues that aide but also influence and steer insights [14], for example through tacit knowledge and implied social and political values and assumptions [15]. Most recently we have reported on how small displays that present local data on the façades of households are interpreted differently by passers-by based on the social relations, connotation and reputations of the households [16].

3. CITIZEN DIALOGUE KIT

The toolkit was developed over a period of 2 years. During the first year we crystalized its concept, through a series of iterative adjustments based on the results from case studies with low fidelity prototypes in three different European cities (Santander, Antwerp, Aarhus) [16]. In the second year, we developed more robust prototypes, released them as open source [17], and developed a participative methodology that aims to aid citizens and other organizations in deploying the toolkit effectively. Similarly, to the initial concept, the methodology was refined through the critical analysis of iterative workshops with municipal workers and citizens in two European cities (Aarhus and Leuven).

3.1 CDK Methodology

The CDK methodology consists of two workshops (phase 1-2), technical instructions (phase 3) and guidelines to monitor, maintain and interpret the results of the deployments (phase 4). In the first workshop a topic, target audience, physical context and goal is determined along with the appropriate data and data sources. In the following workshop, participants start from this data to ideate visualization concepts and polling questions. Here, we particularly aim to leverage the use of data visualization to potentially lead to meaningful insights that reach well beyond conveying just facts or (sensor) measurements. Finally, participants mock-up the locations in the neighbourhood where they think the target audience can be reached, as well as to determine a contextually relevant narrative that binds all the visualizations and polling questions.

3.2 CDK Technology

The open source software for the visualization devices is designed to run on off-the-shelf hardware: a 7.5" e-ink display, a 3G-enabled microcontroller and a battery. Together these components allow for flexible and self-reliant deployment. Integrated polling buttons encourage passers-by to reflect and leave their opinion behind (see Figure 3).

4. INITIAL DEPLOYMENT

The local government supported a group of citizens (Civic Lab Leuven) in their bottom-up quest to measure the air quality in the whole city. As such, local citizens were invited to apply together with neighbors to subsidize the acquisition of an air quality sensor that can be mounted on their facades. In participation with these citizens, we offered our toolkit to help determine the most relevant data variables, the most approachable visualization techniques and their potential location within the city.

4.1 Co-creation workshops

We led two workshops with citizens (4 and 6 respectively) engaged in this bottom-up initiative (see Figure 1) to evaluate the first two phases of the CDK methodology.
Sparked by a recent news report on the impact of bad air on young children, the workshop participants quickly came to the agreement that those most sensitive to bad air should be the target audience; young children and their parents. The city park was suggested as a potential context where they might encounter these displays. The goal the participants established was to communicate the sources of unhealthy air and encourage citizens to actively change

behaviors. Polling questions such as "How do you estimate the air quality in Leuven?" or "What are you willing to do to help improve air quality?" were raised for the polling feature. The participants drafted corresponding answering options specifically to relate to everyday life and a personal impact on air quality, e.g. not using coal at a barbecue, no bonfire at camp or a tax on wood stoves. A focus on fire related air pollution emerged from the sessions as a result of the specific sensitivity of the sensors used by the participants for this type of pollutants.
Participants listed the required data sources, including their own measurements, as well as exposure limits set by the WHO and statistics on the sources that contribute the unhealthy air. In the second workshop the visualization of this data was conceptualized with the goal of easy readability, including by children. A simple line chart would communicate their air quality measurements from the past few days with a clear indication of exposure limits. Pictorial charts were suggested to visualize the sources of unhealthy air. The narrative proposed by the participants leads the passer-by from the air quality measurements over to the sources of pollution and finally to the poll about the actions they could take as a conclusion and topic for debate.

4.2 Deployment

Based on the outcome of these workshops we subsequently deployed the wireless displays in the city park over a period of several days to get a first impression of their performance in a real-world urban environment (see Figure 2-3). Although it remains challenging to draw the attention of passers-by [18], people who frequently pass by the location seem to notice something new and unusual, often mentioning that the colors drew their attention and that they were convinced to stop and take a closer look when seeing the embedded electronics ("Not just an advert, something interactive"). Regularly moving the installation to trigger this novelty effect may be a strategy to increase visibility. Initial observations and interviews point to increased engagement when polling is enabled (e.g. "Hey, you can't vote yet, you need to read the chart first!"). The deployment also indicated a potential to trigger reflections that relate the data to the local context (e.g. about a peak in pollution, "Why then? Does it have to do with less students in the city?" or "It will get worse here, soon the busses will be rerouted").

5. IMPLICATIONS

The first results of the deployment of our CDK revealed several preliminary implications for the design of situated visualization.

Figure 3: A passer-by leaving his opinion on local air quality levels.

Visualization literacy and comprehension. Public visualizations [4] generally aim for a wide audience. This implies varying levels of visualization literacy and expertise on the topic addressed. Through narratives we can aid comprehension [13], but we have observed that if understanding is lost, passers-by did not participate in the poll. For instance, one passer-by said "Is one hundred good or bad? I don't know so I didn't vote". Another explained "I didn't vote because I don't know what PM means", subsequently he did vote on the second display, saying that the "pictograms were easy to understand and I want to contribute".
Contextual relevance. While the extreme flexibility and mobility afforded by the wireless 3G connection and battery enables a potential for a strong contextual and meaningful relevance of the visualization to its environment, the physical (e.g. space syntax), temporal (e.g. fluctuating air quality) and social (e.g. demographic) implications should equally be considered in each context.
Resolution and monochrome. The e-ink display technology, chosen for its low energy usage and resulting portability, only allows a small display resolution that limits the complexity and sophistication of the data visualization. Combined with the monochrome style of rendering, the potential visual encodings are limited. We therefore looked to older seminal works such as Bertin for inspiration [19].
Data update rate. The update rate of the visualized data can be determined based the data source, context and the desired duration of the deployment. While a lower data update frequency is beneficial to battery life, it can lead to a disconnect within the user interaction flow (e.g. when the next update is expected). However, it has also been suggest-

ed that a low update rate could perhaps focus attention to specific moments through scarcity [20].

Display refresh rate. The e-ink display technology has a slow refresh rate (larger than 6 seconds), requiring similar consideration when designing the interactive modalities (e.g. for polling) or narratives (e.g. choosing multiple displays over pagination on a single one). We used a buzzer as an auditory confirmation of a vote, but have also considered integrating LEDs.

6. CONCLUSION

We have outlined our ongoing research into the bottom-up creation of interactive situated visualizations, i.e. representing local data within the public environment to which passers-by can react. We summarily described the design and first deployment of the tool and discussed some implications for designing situated urban visualization. In future work, we will continue to refine the CDK methodology, explore the design space of the technology and evaluate the impact on participants, passers-by and the wider neighborhood.

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