Towards a DataPlace: mapping data in a game to encourage participatory design in smart cities

Conference or Workshop Item

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ABSTRACT

The smart city has been envisioned as a place where citizens can participate in city decision making and in the design of city services. As a key part of this vision, pervasive digital technology and open data legislation are being framed as vehicles for citizens to access rich data about their city. It has become apparent though, that simply providing access to these resources does not automatically lead to the development of data-driven applications. If we are going to engage more of the citizenry in smart city design and raise productivity, we are going to need to make the data itself more accessible, engaging and intelligible for non-experts. This ongoing study is exploring one method for doing so. As part of the MK:Smart City project team, we are developing a tangible data look-up interface that acts as an alternative to the conventional DataBase. This interface, or DataPlace as we are calling it, takes the form of a map, which the user places sensors on to physically *capture* real-time data. This is a simulation of the physical act of capturing data in the real world. We discuss the design of the DataPlace prototype under development and the planned user trials to test out our hypothesis; that a DataPlace can make handling data more accessible, intelligible and engaging for non-experts than conventional interface types.

Keywords

Smart City; Citizen Participation; Open Data; Bottom-up Design; Pervasive sensing; Data Literacy; Tangible User Interface; Embodied interaction; Serious Games

1. INTRODUCTION

The emergence of interconnected digital technologies is transforming how city councils conceptualize citizen participation in urban development. Previously, city planning, design and development was the preserve of governments and technocratic organizations alone. Expert teams of designers, architects and engineers worked alongside city councils to instrument new social and physical infrastructures. The decision-making for such projects was informed by static data and driven by internal discussions within the team about the impact of the proposed work. In some cases, council-owned historical data was consulted. In others, technicians were hired to gather environmental data for the given project.

There was little attempt to involve citizens as participants in urban development projects. The issues were deemed too complex for citizens to understand and contribute towards and the process of consulting citizen's views promised to make development slow and overly bureaucratic. However, the emergence of pervasive, interconnected digital technology in the last decade has now led to a shift in perspective. Three technological developments have had a galvanizing effect: Firstly, the interconnectivity of wired and mobile internet has provided a medium through which to engage citizens easily in the design process on websites and mobile apps. Secondly, the development of sensors that can be embedded into the city environment, the increasing ubiquity of mobile devices and the acceptance of open data legislations by governments, has led to the development of a richer and more accessible data set that describes the whole cities health in real-time. Thirdly, advances in prototyping technology has encouraged expert designers to work with citizens in hands-on design. These technological developments are being put into practice in smart city programs across the world, in the form of web and mobile applications that let citizens comment on council policies and report issues, hackathons, living labs and maker spaces that let citizens work with professionals to prototype and test new city infrastructures, and council owned websites that release raw, data publically online.

Our central concern in this project, is the current plight of the third of these practices. For while there has clearly been good progress in opening data up to the public, there is little evidence of the general public then using this data to build applications of their own volition. It is apparent that there is a knowledge gap between the technical skills that most citizens possess and those that are required to turn open data into applications. Only a small minority of *tech-savvy* individuals are currently capable of comprehending how to use the raw data.

It appears that if we are going to engage more citizens in design, we are going to have to do one or both of two things: A) Convert the raw data into a more intelligible form online, or B) Educate citizens so they know how to use the raw data in its current form. The DataPlace project is looking to facilitate both of these interventions. The first objective of the project is to develop a fun, interactive, educational tool that can help to enhance the data literacy of citizens. The second is to then use this tool as a medium and stimulus for citizens to design smart city applications with real data.

2. BACKGROUND

There is no single definition in research or design circles for what a smart city should be and what it should consist of. Some instances focus on the development of smart physical infrastructures that can provide governments with intelligence about the city environment. Others prioritize the meshing together of social organizations with technological infrastructures. Others still, focus on the impact that individual citizens can have on the city and search for ways to harness the city's human capital. (See [4] for an overview). One commonality which almost all smart city approaches share though, is an appreciation of the importance of using data to provide urban intelligence. The application of data is central to the whole smart city concept. Its significance is summarized by Kitchin et al. who states that it, 'can make a city

knowable and controllable in new, more fine-grained, dynamic and interconnected ways.' [3]

There are three main constituent parts of the process by which data is used in smart cities to generate intelligence. Firstly, it is gathered with sensors or human input on web or mobile apps (instrumentation), secondly it is transported along a wired or wireless network (interconnection) and thirdly it is analyzed, converted into something meaningful and transmitted to someone or something that can use it to serve the needs of the city (intelligence) [1]. The first two of these processes rely on a city having the requisite infrastructures to gather data and transport it via the internet. The third relies on the city having a knowledge economy suited to generating applications for the data. To successfully turn the data into services that are meaningful for the people living in the city, developers must be able to make sense of the data, have the creative and technical skills to use it and, perhaps most importantly, understand what kind of problems need to be solved. At first, smart city developers turned to computer scientists and engineers to develop data-driven smart city applications. More recently we have seen the emergence of citizen engagement platforms that look to the citizenry as a source of ideas and designs [6]. This second movement has come in response to the fact that citizens offer a better insight than technocrats do into the real life everyday problems that affect the city.

The Milton Keynes [8], Amsterdam [9], Barcelona [10] and New York [11] smart city programs have all seen the development of open data hubs; websites that allow citizens to access open data. The opening up of data by city councils in these smart city programs parallels a broader shift towards open data across and between nations. We have seen commitments to open data legislation in many countries - those in Estonia, UK and Sweden http://www.opengov.se] are notable for their proliferation. A review of current open data practices by Jannsenn et al. concludes that although there does appear to have been some progress there is still much space for development before truly open data is achieved. He says that in many cases governments have presented the data to citizens selectively or in a nonsensical form which reflects a more general unwillingness of governments to embrace the open data ideology [2]. Jannsenn performed interviews with members of the public to gather evidence of their opinions and experiences with open data. His findings suggest that there are currently a number of barriers that prevent citizens from converting open data into something useful. Key amongst these are citizens having a 'lack of knowledge to make use of or to make sense of data', 'no statistical knowledge or understanding of the potential and limitations of statistics,' and 'no time to delve into the details or no time at all.' Against this backdrop a number of voices have begun to call for smart citizen rather than smart technology focused development. Rogers et al. summarise this position when they state that, "we should consider how to make people smarter through their use of technology. Moreover, rather than striving for ever more efficiency we should be promoting *engaged* living, where technology is designed to *enable* people to do what they want, need or might not have considered before by acting in and upon the environment [5]."

3. THE DATAPLACE CONCEPT
Our objective in this project has been to explore whether it might be possible to build a new type of interface that makes data handling more intelligible for non-experts. The conventional approach to presenting a large group of data sets on one computer interface is the database. Through a database, users are able to look-up key terms and compare different datum by querying them against each other. The advantages of this interface are the speed and flexibility with which different data sets can be accessed and manipulated. This efficiency comes with a tradeoff, though. To maintain their efficiency and simplicity, databases are given a clinical look. They lack visual stimulus that could provide context for the data. The data itself tells a story about the real, physical world, but there is often nothing in the database that makes an immediate link to this association. Moreover, until a data set is analysed in depth, it may be difficult to perceive it as anything other than a set of numbers or words trapped in a digital space.

Our design solution for a new data handling interface is intended to create a richer and more immediate association between the data and its source than databases currently provide. Specifically, we aim to use cartographic imagery to make the link between data sets and the physical place from which they have derived. This, we hope will help non-experts to grasp the meaning of data and make the data handling task more engaging. We have coined the term DataPlace, as opposed to DataBase, to capture how this interface would function. The term DataBase implies that the data is static and stored in a specific location. ie. in the computer. The term DataPlace is intended to represent how real-time data is in fact physically distributed across a region rather than in one specific place.

To symbolize the spatial representation of data, in a DataPlace it is accessed through the medium of a map. The map is a scaled down version of the whole geographic region from which all the data derives. When the user wants to garner information about a particular region or feature of the environment they physically place sensor symbols, representing the type of data they require, on that region of the map. As soon as the user has placed a sensor on the map, the data for that sensor type and location will start arriving in real-time at their computer interface, where it can be manipulated with digital tools.

The interactive map, or DataPlace as we are calling it, is designed to simulate the process by which data is actually captured in the real environment. We could just as well develop a GUI system, where the map is represented in pixels on the screen and interacted with a mouse. Instead though, we have chosen to develop an interface that encourages tangible interaction. This builds on a body of previous work that has underlined the cognitive benefits of tangible interaction. Ullmer, Ishii and Jacob experimented with physical tokens for manipulating data on a tabletop interface as far back as 2003. (Tangible query interfaces). They found that giving "physical form to digital information," can help users to "focus on objects of interest." Paul Dourish has since spoken of the psychological impact of physical interaction with data. He has argued that our "experience of the world is intimately tied to the ways that we act in it," and that "interaction is intimately connected with the settings in which it occurs." In a recent paper, Stusak et al.[7] have found that holding and manipulating tangible 'data blocks' can improve memory recall. We aim to invert this approach of Stusak et al. and explore the cognitive benefits of physically representing the environment from which the data derives, rather than the data.

4. The DataPlace Board Game

The development of the DataPlace will be structured across two stages. For the first stage of the R&D process we will be creating an augmented board game which will use dummy data. This game will be distributed to citizens in Milton Keynes as an educational resource. It is intended to encourage playful interaction with data, competition and gamified learning. The map for the game is of an imaginary city with a surrounding semi-rural area. It has been modelled on real life cities. Starting with a dummy-data version of the game in an imaginary city like this will enable us to run some initial controlled empirical user tests that focus purely on how people conceptualize data. It will marginalize environmental conditions, such as the users' knowledge of the city and the impact of real life data, that could influence the interaction. For the second stage we plan to channel our findings from the research with the board game into the creation of a new map that uses real-time data, dynamically retrieved from the mk:smart open data hub. (https://datahub.mksmart.org). This will manifest the objectives of the DataPlace project – live data accessed through a physical map.

Fig. 1 Participants discussing where to place their sensors on the map in the paper mock-up trial of the game.

We are currently in stage one of the design process, prototyping and testing the game mechanics. To gain an initial insight into the kinds of social and educational dynamics that the board game would create, we developed a rudimentary paper mock-up of the game and trialed it in a workshop (fig 1). For this workshop, participants were split up into groups of 4-5 people. Then they were given the imaginary city map and a range of cards with different sensor symbols on them (fig.2. They were also given two questions to respond to. These questions were, "The town council is considering different forms of renewable energy. Find some data that could help them to decide what type of energy is most suitable," and "Funding has become available to establish a new nature walk. Find some data you could use to help plan where it should go." The participants were instructed to choose a set of appropriate sensors to respond to the questions and then place them on the map in the most appropriate position. While the groups of participants were engaged in the task, two experts moved between their tables and observed their behavior, making notes and capturing quotes. Participants were also asked to write a retrospective reflection of how they felt the task went. We received some positive feedback about the task – e.g. 'overall, a stimulating exercise which everyone engaged in', and some advice for how to improve it – e.g. "We noticed that local planning data was missing."
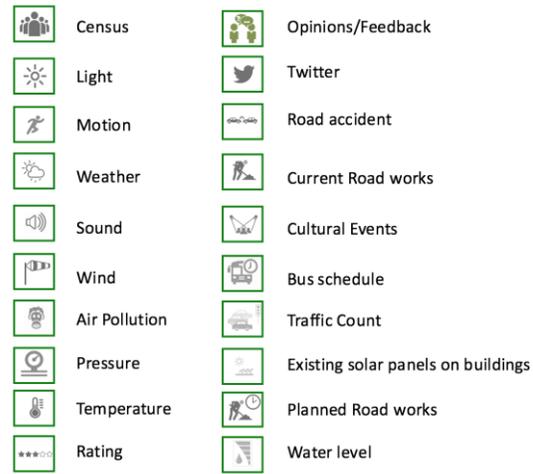

Fig 2. The full set of sensor symbols used in the paper-mockup trial of the board game

We used the participant's feedback in this initial trial as a guide for the further development of the game mechanics. This included the introduction a points system. We then iterated the paper-mockup user trial with the new version and after some further adjustments and refinements finalized the mechanics of the game. We are now at the stage where we are ready to print the game board. A graphic designer is currently in the process of creating fun and colorful graphics for the design.

Simultaneously, while developing the game mechanics and graphic design, we have been working on the interaction modalities for the game, i.e. how the user gets access to the data. To explain how the user interaction works, we will describe how a user plays a move:
Initially, at the beginning of the game, players are given a shared game board with the map on it, a mobile phone and a set of questions that they must respond to. To play their move, they choose an area of the map where they would like to place a sensor. Their decision of where to place the sensor and what sensor type to choose is based on their ideas about which regions of the city may produce data that can answer the question. So, for example, if the question is *how should the city improve its transport system,* they may decide that the best place for the sensors is on the roads, where they can count the number of cars, buses or citizens on the pavement.

The selection and placement of the sensors is where the interaction comes in. Game players select a sensor type on the phone and then place the phone on the area of the map where they would like to situate the sensor. As soon as the sensor is in place they begin receiving data from that position of the map. There will be a matrix of near field communication tags embedded into the material of the game board (Fig 3). These enable the phone to address the different regions of the map and change the data that it outputs. As soon as the user has selected their sensor and addressed the region on the board, blocks of data start appearing on the phone (Fig. 4) Simultaneously, they receive points for how much intelligence the sensor provides for them about the question they are trying to answer. This is the end of their turn.
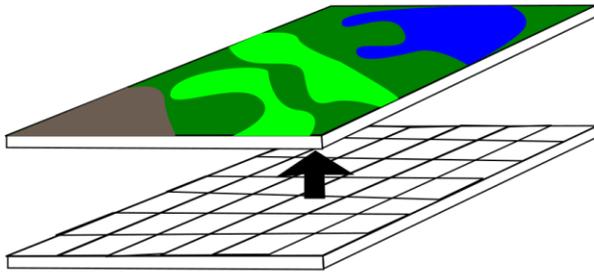
Fig. 3 Cross section. A matrix of NFC tags will be glued onto the back of the game board map.
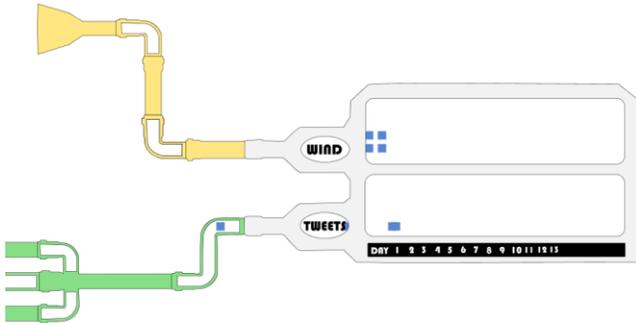

fig. 4 GUI developed for the phone interface showing the blocks of wind and tweet data streaming in.

Each turn in the game represents a day. On each day the user adds a new sensor to the map and more data pours into their phone. At the end of the game, when 13 days have passed, the person whose data has generated the most intelligence points is the one who wins.

5. DISCUSSION AND CONCLUSIONS

This project is in the development phase so it is difficult at this point to comment on the impact that it might have on citizen participation. The only evidence we have so far, is from the observations made during the trial of the low fidelity prototype of the game. The response from users during these trials has been promising and does suggest that DataPlaces may bring a new, productive dynamic to open-data engagement. We noted that the users were focused during the task and that the game stimulated lots of fluid discussion about the meaning of different types of data and the strategy that should be used for gathering data. This is the kind of immediacy of engagement that we had hoped for. Janssen's analysis of citizen participation in open data platforms has found that one of the major obstacles is that citizens simply don't have the amount of time and effort that is necessary to make sense of data in conventional open databases. Early indications are that our platform may provide some solutions. The association of the data with a place on the map, appeared to stimulate the participants creative thought in the trial. Controlled experiments will be required to test this hypothesis further.

The DataPlace platform that we are developing will not have the flexibility of a conventional database and its use is unlikely to lead directly to the development of applications. It could have an indirect impact on citizen participation though. It may help to engage and educate more members of the public and improve their grasp of how powerful and meaningful data can be. Over the coming months we will be testing this hypothesis as we run user trials with the finished game prototype.

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