Sens-Us: Designing Innovative Civic Technology for the Public Good

Connie Golsteijn[1], Sarah Gallacher[2], Licia Capra[1], Yvonne Rogers[1]
[1] University College London, UK
[2] ICRI Cities, Intel Corporation (UK) Limited
info@conniegolsteijn.com; sarah.m.gallacher@intel.com; l.capra@ucl.ac.uk; y.rogers@ucl.ac.uk

ABSTRACT
How can civic technology be designed to encourage more public engagement? What new methods of data collection and sharing can be used to engender a different relationship between citizens and the state? One approach has been to design physical systems that draw people in and which they can trust, leading them to give their views, opinions or other data. So far, they have been largely used to elicit feedback or votes for one or two questions about a given topic. Here, we describe a physical system, called Sens-Us, which was designed to ask a range of questions about personal and sensitive information, within the context of rethinking the UK Census. An in-the-wild study of its deployment in a city cultural center showed how a diversity of people approached, answered and compared the data that had been collected about themselves with others. We discuss the findings in relation to the pros and cons of using this kind of innovative technology when wanting to promote civic engagement or other forms of public engagement.

Author Keywords
Physical survey; opinion gathering; public opinion; civic engagement; in-the-wild study; Census data; public good

ACM Classification Keywords
H.5: Information interfaces and presentation (e.g., HCI): H.5.m. Miscellaneous

INTRODUCTION
Every ten years, governments throughout the world send out a mandatory questionnaire (paper-based or online) to each household to fill in. A large number of personal questions are asked about work, health, national identity, education, marital status, ethnic background, marital status and so on. The data collected provides *"a detailed snapshot of who we are, how we live and what we do"* [19]. It is also used as a tool to help plan and fund services such as education, health and social services. The decisions and changes that are made, based on this feedback, are intended to map onto the needs of a community [17].

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However, the types of questions, the methods used and survey format have remained the same for many years. How might the Census process be updated to make better use of innovative forms of technology and, in doing so, consider other ways of gathering information? The UK government is especially interested in thinking about how new ways of using technology for data collection could create a different and more open relationship between citizens and the state. What would an alternative census look like if done at a city level, where the city is viewed more broadly in terms of 'public good' rather than primarily as a tool for distributing public funding? How could it be used to ask a wider set of questions about how people participate and how often, what information they want to give towards a public good and what would feel representative of their everyday lives [24]?

To address these questions, we were invited to design an innovative technology for an interactive Citizen Census by [6]. The goal was to deploy our system for a month in a public, civic bureau that would be set up at Somerset House in London as part of the UK Census team's Civic Workshop. Our proposal was to design a quite different kind of survey – one that is physical rather than being digital or paper-based – with the rationale that it would *entice* civic engagement for the public good, when gathering opinions. By physical, we mean a bespoke interactive device that provides a range of physical input devices, such as sliders, knobs and dials that are combined with physically written questions embedded on a console. The benefits of going physical in this manner lie in their potential affordances – that can make a system appealing, attractive and obvious how to use, based on using familiar input mechanisms [9]. By standing out, we hoped it would draw in passers-by as they walked past the bureau, leading them to want to discover and know more about the Sens-Us. We were interested in finding out whether a person, having moved in front of a question box, would feel comfortable enough to divulge information about themselves and then to discover more about what others had also entered.

A central concern for developing such a system is whether the kinds of questions about public good that the Census team were interested in exploring lend themselves to being

instantiated in a physical form. Moreover, would such a physical system be able to encourage the general public who were simply walking past the room to then enter and by their own volition take part? Would people be happy answering a range of personal questions? *In other words, what kinds of information would people be happy contributing to knowledge for the public good?*

The research reported here describes how we designed such a physical survey system. A requirement was that it would be a stand-alone system that could be used for several weeks in a public place – without the need for researchers or other members of the team to be at hand. A further concern was how best to structure and present a large number of questions so that they are both visible and intuitive to answer but also maintain appropriate levels of comfort and privacy. We wanted to see if people would trust a physical device that they had not seen before, with entering their own data while spending some time interacting with it. This meant designing a system that could attract people's attention, sustain their interest, and make them feel comfortable answering a range of personal questions.

We designed a set of physical boxes, called Sens-Us, that were situated in a room made out to be like a Civic Bureau, intended for the public to walk up to and use (Figure 1). We report on an in-the-wild study describing what happened when Sens-Us went public. The findings were analyzed in terms of how many questions people answered, what they were happy to reveal about themselves, how they felt about their privacy, and whether they were interested in discovering more about the results and comparing themselves with others. Finally, we discuss our findings around pros and cons of designing and using physical survey systems in the context of encouraging civic engagement.

BACKGROUND

The public good refers to a range of things for the use and benefit of all, including services, statistics, lighthouses, and parks that are generally provided by governments. The process by which these are selected, placed and maintained is decided by local government, based on information and data gleaned from a variety of sources, including the Census. The decision-making process has typically been black box in nature with little or no input or understanding from the people it is being provided for [10]. Recently, there has been a move towards designing civic engagement technologies where citizens of a community, city or other locale are encouraged to be more actively engaged and have their say [23]. This includes initiatives that allow people to report online things they have noticed or concern them in their neighbourhood, such as potholes in the road, abandoned cars in their street, vandalism and unwanted graffiti – with the understanding that the local council will look into these and act upon them where possible. Typically, these are designed as mobile apps or web-based sites.

Figure 1. Three of the Sens-Us boxes together with the visualization pillar placed in Somerset House, London.

Projects that have sought to use other kinds of technologies include participatory sensing that place sensors in the environment to collect data about air quality, noise and so on [2], voting boxes for gathering local opinions in situ [26] and innovative "data technologies" that are designed to collect and visualize data so that the public can see and discuss together information that was previously unavailable or inaccessible to them [8, 21].

Walk up and use kiosks have been developed and deployed that target civic engagement by using familiar interaction mechanisms, such as on-screen forms and/or request people to submit SMS text messages. For example, the system "Discussions in Space" is an application for public screens that facilitates public civic feedback by interacting through text messages and tweets [18]. TexTales invites young people to take pictures of public issues and enables others to annotate [1]. Similarly, Ubinion is a service running on public displays that enables young people to give their opinions on local issues through photos alongside annotations [11]. Based in a more focused context, VoiceYourView [27] gathers feedback on use and improvements of a local library through public screens. MyPosition asks people to vote on local issues by gesturing in front of a large projected display in a public space [25]. Both Discussions in Space and Ubinion were found to be successful in engaging people that would otherwise not engage in civic debate [11, 18]. The TexTales study further reported triggering discussions on the system and in the physical space around it [1], while with MyPosition many people stopped to look, but only one in four chose to submit an opinion [25]. Other strategies have been used to voice opinions beyond simple votes or text input, such as telephone handsets [9, 27] and megaphones [7].

An overarching finding with these public display systems was that although many people freely gave their opinions, privacy remained a concern that impacted on who participated and what they shared, as people feared others "shoulder-surfing" and seeing their information [5]. Furthermore, some people felt uncomfortable and self-

conscious interacting with the system, especially when they were asked to gesture or talk to machines [25, 27]. A key concern, therefore, when designing civic engagement technologies for public spaces is that people feel comfortable while being curious enough approaching and then at ease when using them.

Another way to address this is to design highly visible and attractive physical systems. It is well known that physical objects and interactions can draw people's attention through their affordances [16] especially when designed to stand out against the environment [12]. For example, Voxbox was designed as a large, physical box with a retro appearance that asked people to submit their opinions and provide ratings using brightly colored arcade buttons, slot machine spinners, and levers [9]. The machine was found to be very successful at drawing people's attention, getting a wide demographic to interact, and gathering opinions about an event they were attending.

Depending on their physical properties and design, such tangible systems can grab people's attention compared to public screen/surveys that they might otherwise walk past [15]. Simple physical voting boxes that show a question and ask users to submit a response by pressing a button have also been found to be effective [14, 22]. Such voting boxes have, for example, been used to gauge people's views about their community and neighborhood in shops along a road, after which collected data was visualized on the street with chalk [13]. Furthermore, simple interactive posters have been used to vote on local issues as an approach for political activism [26]. A novel interface that was designed to draw people's attention was "Vote with your feet" where people had to express their opinion by stepping on physical buttons in the pavement at a bus stop. It was found that the large buttons attracted people's attention much more than the screen that displayed the question and lowered the barrier for participation [20].

These kinds of physical systems show much potential for gathering public opinion because they can draw people in and make it obvious and easy as to how to interact through the use of familiar interfaces, such as buttons and dials. While the examples show that large and diverse audiences can be reached and meaningful data collected, they have so far only been developed to ask a small range of questions about an event or a single topic [3, 13, 22, 25]. What would it take to scale up such a system so that more questions could be asked about a range of personal topics and demographic issues? What other considerations would need to be taken into account?

Our approach is to exploit the affordances of physicality by using an array of colorful physical buttons, dials and toggle switches. The rationale is to make a system stand out and appeal – so that it makes people feel intrigued straight away while also comfortable, and in doing so, want to take part by answering questions and sharing their views [9, 25]. So far the use of physical surveys has been limited to asking a small set of questions about a topic, which require simple yes/no answers, checking a rating scale or giving an opinion about a topic, such as the service satisfaction smiley rating buttons now commonly found in many airports and cafes, that require only a few seconds or at most a couple of minutes to complete. For the Sens-Us project, we were interested in whether we could scale up a physical system to ask a diversity of probing questions that people would be prepared to answer.

DESIGN CONTEXT

To begin, we held several meetings with the Census team to understand what they wanted, what they meant by the public good and to discuss the pros and cons of designing an alternative, physical Census system. We considered how the new system might cover a range of subjective topics that go beyond the existing set asked in the current Census, including ones referring to a sense of belonging and trust in society. We ended up with 54 questions that the physical system should ask, of which 6 were about demographics and the others were divided equally across 4 themes (12 questions per theme): health, belonging, place and trust. Table 1 shows some examples of questions in each theme.

Questions in the demographics theme included age, sex, education level, income, postcode, and duration of living at that postcode. Questions in each of the other themes were divided into three categories (4 questions per category) that were about what information they would be willing to share and what information other people might want to know:

1) *Direct questions:* personal questions, for example, whether they were registered organ donors (health), whether they felt they were in a minority where they lived (belonging), whether they had planned how to support themselves in older age (place), or whether they thought others trust them easily (trust).
2) *Reported sharing questions:* asked people with whom they would be willing to share certain information, provided it was anonymous. Example questions included: how many times they had visited their GP (health) and whether they shopped locally (belonging). For each item, it was further asked whether someone would share this information with any of three parties: "close family and friends", "city council", or "public good" (which means that their data could be used by anyone as open data). Multiple answers were possible for each question.
3) *Knowledge questions:* questions about what information the person felt should be available to them, such as how social media websites use collected data (trust), or their friend's whereabouts during the day (place).

DESIGNING SENS-US

The overarching principles that were used to inform the design of the Sens-Us system were: discoverability, flexibility, manageability, privacy, and feedback.

	Controller	Illustrative example questions from Health box
cat. 1	Rotary dial	What blood type are you? (A+, A-, B+, B-, O+, O-, AB+, AB-, I don't know, prefer not to say)
	Slider	Which health services do you use? (private health care all of the time, mixture of private and NHS, NHS all of the time, other, prefer not to say)
	Toggles	Do you give blood? Have you had unprotected sex? Are you a registered organ/tissue donor? (yes, no, prefer not to say)
cat. 2	Check buttons	If your data was anonymous, who would you be willing to share the following information with? (select all that apply: close family and friends, city council, public good): How many times you visited your GP in the last year? Any hereditary conditions you are likely to get? Any symptoms you have on a regular basis?
	Yes/no buttons	Do you think this information should be available to you? (yes, no): The average weight of adults living in your neighbourhood? The leading causes of death in your neighbourhood?

Table 1. Mapping of controllers in categories 1 (answer is visible after submitting) and 2 (answer is not visible) to questions.

Discoverability
The physical systems needs to be designed to stand out and enable people to discover it in their own time and decide whether to participate on their own terms. It should entice people from seeing the system to then using it.

Flexibility
The system needs to be able to accommodate individuals, pairs or groups so they can use it at the same time, either by going their own separate ways or together. Families, couples, groups of friends or people on their own should be able to use it at the same time. It should also be able to cater for several groups/individuals using it at the same time to prevent the need to queue or wait to have a go.

Manageability
The set of questions needs to be structured to be manageable in terms of how much effort and time is required to answer them by passers-by. We wanted people to feel reassured and at ease when starting to fill out a survey knowing how many more questions there were to complete it.

Privacy
As the system was going to be used in public it needed to provide enough personal space for someone to use and feel they are not being overlooked.

Feedback
Filling out a form, such as the Census, is usually one-sided; people don't see the data afterwards. We wanted our system to be able to visualize people's answers relative to how others had answered so that they could all see how they compared with each other in the moment (and later via a website).

The Design of Sens-Us
We developed Sens-Us as a set of five interactive physical boxes that had a console with either 6 or 12 questions embedded in each (see Figure 2). Having five boxes rather than one meant that the questions could be broken down and grouped by a theme while making answering them more manageable. It was envisioned that it would take a person between 1-3 minutes to answer the set of questions at each box. A data visualization station was also designed to provide aggregated answers as feedback of the answers that had been provided by the participants (see Figure 1). The questions were laid out on each box in a grid on a 60x40 cm slanted console, following a logical flow from left to right and top to bottom. The boxes were created out of 5 different brightly colored laser-cut acrylic pieces intended to be attractive and approachable. They were designed to be at an average adult waist height and the interaction console was slanted to make for easy interaction. Side panels were added to the boxes that were intended to obscure the interaction space from the side to provide a level of privacy. The design of the boxes was intended to be stand-alone, making it obvious how to interact with them. Information about each theme and the reasons for asking the questions was to be presented via posters located above each box.

To combine and compare people's answers at different boxes to each other, we developed smart cards that used card registration (using NFC technology). A card is activated when inserted into a box. The data from each box was then saved to the card's ID on removal, and in this way all data from the different boxes was linked to the same user regardless of which boxes they used. This linked data could then be shown when the card was inserted into the visualization station. The cards were also designed so that they could be taken away as a souvenir.

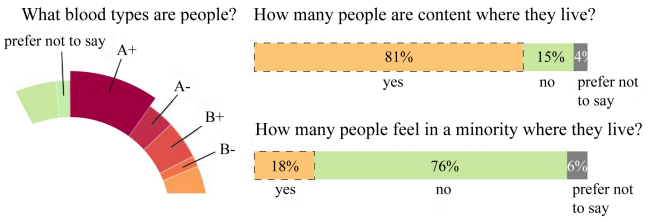

Figure 3. Examples of data visualizations: a. blood type chart (partial view) with participant's answer enlarged; b. belonging questions with participant's answers dashed.

Two types of controls were used for answering questions on the boxes. Table 1 shows the mapping of different controllers in relation to the questions. The first category of controls left answers visible after submitting them, and included linear sliders, rotary dials (which both had multiple options along their scales, including "prefer not to say"), and three-point toggle switches (which could be set to "yes", "no", or "prefer not to say"). These were used to answer the *direct questions*, i.e. personal information about the user (Figure 2a). The second category of controls did not leave answers visible after submitting them, and included small push buttons with an LED next to them that were mapped onto the *reported sharing* questions (Figure 2b). The other type of push buttons in this category was illuminated "yes" and "no" push buttons that were used to ask the *knowledge questions* (Figure 2c).

A data visualization station was designed to provide feedback in the form of a digital display that showed someone's answers relative to the aggregate of others' answers to individual questions. Different types of canonical graphical forms were used to depict the answers as an aggregate across all respondents (see Figure 3 for an example). The display was embedded in a pillar that was situated in the middle of the room with plenty of space around it for people to use it without others invading their space. It could be visited easily from any of the boxes and was flexible so that people could look at it whenever they wanted. It was designed to be at eye height and small enough to shield it from others. Placing a smart card into a slot resulted in the personal visualizations appearing on the screen. To browse through them "next" and "previous" buttons were provided.

Physical Setting

Sens-Us was placed in a small room (6x2.5 meters) in Somerset House, a major arts and cultural center in the UK. The room could comfortably accommodate up to 20 people at a time. This location was chosen for its potential to attract people walking by, and to create the impression of entering a census bureau. The center has numerous cultural and educational events happening during the week and at the weekends, which attracts both tourists and locals.

The boxes were spaced out with approximately 1.5 meters between them so that people could use each box privately (similar to the way a bank of ATMs are positioned along a wall). They were placed against the walls as someone walked in (three on the right and two on the left) to suggest a sequence from the door in a counterclockwise fashion. However, people did not have to follow this order, but could choose which way to answer them. If someone else was already at a box they could walk up to another that was free.

IN THE WILD STUDY

Sens-Us was deployed for four weeks at Somerset House. Modest signage was placed at the entrance of the building and a press release was sent out. Other than this, no active recruitment of participants took place by the researchers. The emphasis was for people who had come to the cultural center to decide what to do upon encountering the room.

During the deployment, we collected all the answers to the questions provided and the date and timestamps of when people used the question boxes. We further spent time over several days observing the Sens-Us room, unobtrusively positioning ourselves outside the room. We observed 34 people using the system, watching how they used the boxes; and if groups interacted with each other while using the system. We also conducted brief semi-structured interviews with 18 participants after they had interacted with Sens-Us. Interview questions included whether they knew about the project or had stumbled upon it; how the experience related to doing a census survey; if they had any concerns about their privacy, and if there was any data that surprised them.

Identification tags from the smart cards, along with time stamps and which boxes were completed were used to identify different users; for example, if a card had been reused by different users we were able to tell because time stamps did not match up and/or boxes had been completed multiple times with different data. Because we did not collect any personal data we could not verify if some users may have come back and participated again but this is unlikely giving the nature of the questions (i.e. it concerns higher level views that are unlikely to change significantly over four weeks' time). However, we did speak to one person who had come back with her parents because she wanted to show them the system. She had participated during her first time in the room and now stood back to let

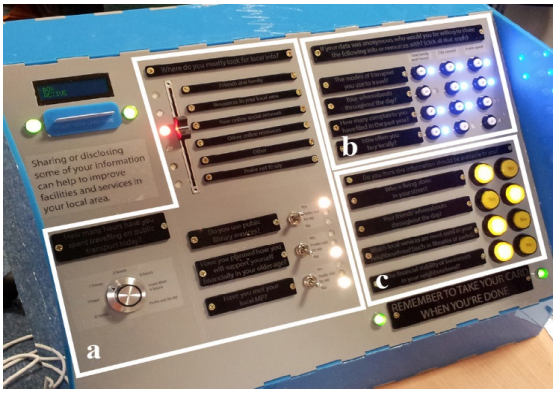

Figure 2. An example question box with different controllers: toggles, slider, rotary dial; check buttons and yes/no buttons.

her parents participate.

There was the occasional day when not all five boxes were operational because of technical issues – the data from these days was excluded from our analysis.

FINDINGS

Overall, the Sens-Us system attracted a diversity of people, from individuals to groups, who answered some or all of the questions. Many also looked at the feedback provided as visualizations about how they compared with others. People appeared engaged and intrigued by the system as evidenced by the time they spent at the boxes, the questions they answered and the conversations they had with each other. No-one seemed worried about why they were being asked these set of questions.

Of the people interviewed, half did not know about the project and just stumbled upon the room and proceeded to interact with the boxes. Of those who did know about it, some came on a group trip after they had heard about the project. Participants (P) were very positive about their experiences of using Sens-Us. Comments from the different Ps included, *"It is much more fun than filling in a survey form"* (P4*);* "*It is more efficient than the way the census is currently done"* (P8)*; "This is more interesting and interactive. It is not just filling out a boring form. It's great to have something physical that is yours*" (P10); *"This is more personal. The census is so general. This is much more local and personal – it's closer to home"* (P7) and *"There should be a room like this in every council office in the UK."* (P6). These comments and the number of people who interacted suggest that people took part on their own terms because they were interested and that they found the experience very engaging.

The majority of respondents did not remember filling out their last census, were not UK residents, or were too young to have done it before (i.e., teenagers). Those who did remember were often a bit hesitant, for example, P15 said, *"I think so. It was on paper I think."* When people were asked if they had any idea what currently happens with census data and where they could find this data, most had never looked for it. P5 noted, *"you can probably find it online half a year later or so"* while one man (P18) knew *"It's actually not that simple to find it"*. Another man (P14) joked *"you probably won't see it until they show it on The Today Programme!"* [a current affairs program on British radio]. Two teenagers said they had only looked for it and used it for history lessons as research (P2, P3). Another lady (P7) commented *"it seems that not a lot happens with it. […] It seems they [the government] are just going through the process [of doing the census] to check the box."* As surmised by the Sens-Us team, not many people are aware of what happens to the data collected from individuals and communities.

Of the people who answered the questions on the demographic box, 43% were male, 53% were female, while 0.5% identified as trans* and 4% did not answer or selected "prefer not to say". A wide distribution of ages was recorded: 12% were between 60 and 69 years; 16% were between 50 and 59 years; 12% were between 40 and 49 years; 11% were between 30 to 39 years and 13% were between 20 to 29 years. 73% of people were from the UK; 14% were from abroad, and 13% did not answer this question. Income was also widely distributed, 27% saying they earned £50,000 or more annually and 56% earning between £17,000 to £49,999 and the others not answering. Below, we analyze in more detail how successful the Sens-Us system was in terms of (i) extent of participation, (ii) privacy issues, and (iii) the effect of providing feedback on user engagement.

(i) Participation 731 people interacted with one or more of the boxes during the deployment – roughly 200 per week – as evidenced by the data collected for completing the questions. On average, people took about 10 minutes to complete the set of questions at each box - about two minutes per box. Overall, 33% of people completed the questions for all 5 boxes, 19% completed four boxes, 14% for three boxes, 12% for two boxes and 22% for one box. There were similar numbers of completion for each box, health being the most completed (71%) and trust being the least completed (60%); while demographics was completed by 69%, belonging by 68%, and place by 62%. These levels of completion might appear to be on the low side, but given that there was no requirement to visit all five boxes, a champion to chivy them along or official person to tell them they must, it is remarkable that a third of the people completed all questions at the five boxes.

Possible reasons for partial completion rates could be that some people did not realize that there were different questions at each box; people did not want to wait if someone else was at a box, or simply they had had a go and were ready to move on. To examine further how people used the boxes we mapped out the order in which they answered them according to placement in the room. A third of the participants answered the boxes in the sequence they were laid out in the room: demographics, health, belonging, place and trust. 8% followed the sequence but in the opposite direction. The rest visited them with a particular interest in mind or randomly. One woman, for example, commented that she was very interested in blood types and therefore chose to do the health box first.

We also looked at the effect of how crowded the room was on completion rate and found a positive correlation: the more crowded the room was, the more people completed all five boxes (Spearman's rank correlation, $rho=0.18$, $p<0.01$). This could indicate that people were encouraged to spend longer when others were in the room, that there was a positive "peer pressure" to complete, or that further discussions kept them interested. We also saw that when the room was crowded, people did not give up and leave, but more often diverted from the common box sequence to go

to another box that was free (Spearman's rank correlation, rho=-0.15, $p<0.01$).

Our observations of the room showed that couples, groups of friends/colleagues and families answered the questions together as well as couples. Group members interacted either with a different box, individually, at the same time, looked over at someone's shoulder, or called out questions or answers to others. Overall, we saw that within groups, people mostly interacted individually with the boxes while interactions with each other remained limited to the occasional comment or question. For example, a couple discussed many questions, such as: *"how many neighbors do we know by name?"* (P32, P33). The man answered and his wife replied that they knew more people and started naming them, after which the man corrected his answer on the box. It also occurred that while one person was at the visualization station and another at a box, facts and figures were called out: *"12% had unprotected sex!"* (P21). This would often result in the other joining them and going through the data together.

(ii) Privacy A general concern when asking people to divulge personal information in public (e.g. have you had unprotected sex?) is that they might feel uncomfortable answering such questions. When we asked people who had taken part whether they were concerned about this, a few were genuinely surprised while 85% said they were not concerned. Others commented about the system being in public: *"It is obvious for others to look over your shoulder"* (P8), or on the physical nature of the controls, *"Yes, because of the toggles and the sliders. People behind me can see my answers. This defeats the purpose of anonymous sharing."* (P1). Another woman indicated she was not concerned about her colleagues seeing: *"I know them but I'm not concerned. I could have changed the controls – I should have perhaps – but I didn't. Change my age to 18!"* (P15). One man (P10) commented on what information they shared in relation to their privacy and made deliberate choices on what to share: *"I did not fill out any personal information, such as my identity, so that was fine."* Another man (P17) noted: *"The questions weren't linked to my identity, only postcode and gender but that's not enough. I did not give my full postcode, so maybe yes [I was concerned about privacy] in that sense."* P11 commented on the scale of the project: *"If this was deployed in small communities they might have an issue with privacy because it would be difficult to keep it anonymous. In small communities people can put information together and work out who is it."*

At the visualization station some people considered it completely normal to look at the data together and discuss it (and thus peruse one person's personal views), or look over another person's shoulder, while in other situations people respectfully stayed back and queued to wait their turn.

Two of the interviewed people appeared to have a different understanding of how the physical system worked. They were of the impression that their data stayed in the room or lived on the card: *"The fact that it's physical makes me less concerned. It's contained in this room and you know who is doing it. People can still do weird things with it, probably, but maybe less so than if it was online"* (P18) *and "Can I take my card with me? It has my data on it."* (P1). For ease of data collection and processing, Sens-Us was actually connected to the Internet to enable the data to be aggregated in real time for the visualizations.

The toggles, sliders, and rotary dials when switched to an answer stayed in place for others to see – unless the participant deliberately moved it back to the default position. However, during our observations, we rarely observed anyone switching them back. The only exceptions were for questions about age and salary, where a couple of people mentioned that they did not want their colleagues (who were also in the room) to see their answers.

We also analyzed the non-answers to questions to see if there were any differences for particular kinds of controls. Figure 4 shows the means and standard deviations of those that did not answer questions using the different controls. As there were only small differences between the percentages of non-answers within the same control across different boxes, results were aggregated. The figure shows that the sliders and rotary dials resulted in the least non-answers (less than 2%), while the toggles and check buttons resulted in the highest number of non-answers (just over 5% each). Hence, controls that stayed in place did not result in more non-answers than those that did not.

The highest number of non-answers for the demographics box was for the questions that asked for people's postcode (13% did not answer). This could have been because some people did not want to be identified (in the UK a postcode identifies which street you live in). Only 4% of people did not answer the question about their salary – which is usually considered to be quite private information. This low level of non-answer might seem surprising especially as the amount of salary selected was left visible for the next person to view, unless someone chose to slide it back to something else.

(iii) Feedback One of our goals was to determine

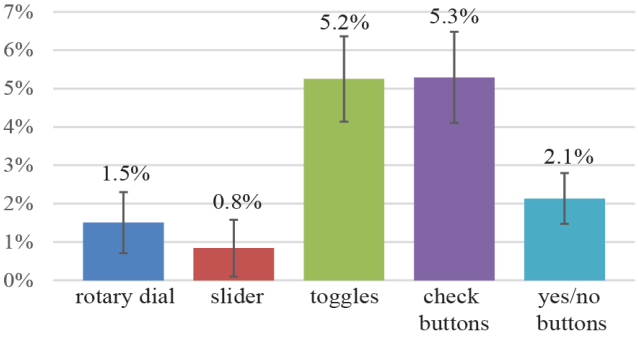

Figure 4. Means and standard deviations of the percentages of participants not answering questions across the five boxes with each interaction controller.

whether people would be interested in discovering more about how others had answered compared to themselves. Of the people we interviewed, 78% said they had looked at the data visualizations, suggesting a high percentage of people were interested in finding out what they and others had answered. Those who did not look said they had not noticed the station or planned to look at the results on the web later. People typically spent between 30 seconds and 8 minutes looking at the data visualizations and most time was spent when there were two or more people looking together and discussing it. Most people visited the visualization station after completing one, two, or three boxes and often went back to the boxes afterwards to complete more. Hence, it appeared that the feedback also played a role in encouraging them to answer more questions and see how they fared compared to others.

When asked if there was anything in the data that surprised them, over 80% people related the data to their own views, interests, and experiences. Two teenagers were surprised by how many people wanted to know the average weight in their neighborhood: *"It doesn't concern you personally, why would you want to know?"* (P2, P3). A woman was pleasantly surprised that half of the people did not know any of their neighbors by name; it made her realize she is not abnormal or a "bad neighbor" (P5). One man (P17) was amazed to see that *"people put a lot more faith in the universe than in the government."* Others related the data they saw to society more broadly. P7 commented on how much some of the data made her concerned about where society was heading, for example that many people sold gifts instead of giving to charity, that not many people had made a plan for financially supporting themselves, and that so few people were donors or gave blood. One participant (P17) commented that the data visualizations would be more useful in his local community: *"[Then] I knew how my opinion related to those of my neighbors. Now I know this is only from people who visited this exhibition and I don't know who they are so I don't care that much. Local would be more interesting."* This feedback proved to be thought-provoking and revealing in ways people had not thought about before, suggesting it is a valuable way of connecting with people who are happy to give information about themselves.

DISCUSSION

The findings from the deployment of Sens-Us revealed that a large number people from diverse backgrounds, who happened to be passing the Civic bureau room, walked in and answered the set of personal and sensitive questions about themselves. It made them curious about the Sens-Us project and the way they could see how they and others had answered. Furthermore, they did not appear to be concerned about leaving their selected answers visible at a box for others to see what they had answered. The high level of completion rate could be partially due to a honey pot effect [4], where people are drawn in, when seeing others interacting with the boxes. Our study also suggests that the affordances provided by the physicality of the Sens-Us boxes attracted people, who then became engrossed in answering the range of questions. People knew intuitively how to interact with the boxes despite them being completely new to them. Seeing their answers relative to what others had answered - in the form of digital visualizations appeared also to encourage people to go to the other boxes to answer and find out more. They found it intriguing to provide and receive in return personal and sensitive information about themselves and others.

The Sens-Us project demonstrated how a diversity of passers-by participated when asked to answer a range of far-reaching questions. It suggests that the kinds of questions about public good that the Census team posed were ones people were interested in. Moreover none of the participants complained or mentioned privacy as a concern – which could have been a potential problem. A few were puzzled about the information that was being asked for in terms of how it might be for the public good (e.g. the weight of people living in their street). But overall, it proved to be a successful way of attracting people and raising awareness about how information can be gathered about people, their demographics, their health, their sense of belonging and trust, and how all of this might be made available to others.

It was not possible for us to determine how many people walked into the room and decided not to engage with the boxes. During our observations we saw some people wait for a while when it was busy, and then walk out. This presumably was because they did not want to hang about. There were also people who poked their head in and decided to then not enter the room. This is likely to be the case with any public installation, where some people remain as bystanders or choose not to partake.

One way we could have found out why people did not take part was to ask those who walked past. However, we felt it would have been inappropriate to approach people like this and ask why they had not used the boxes. Being approached by a stranger in this way might have felt accusatory and have either put pressure on them to then interact with the boxes or result in people being defensive or even abusive – as can happen when asking people why they have *not* done something. The Sens-Us team were also not interested in trying to get as many people to answer as possible but more interested in observing and finding out more about those who chose to voluntarily answer the set of questions.

Our findings suggested that there was no real preference for widget type in terms of which controls were easier to use, or more comfortable for participants. Our rationale for using a mix of physical input devices was both to vary the way questions could be answered and in terms of appropriate mapping between question type and form of answer (sliders for continuous Likert scales and discrete buttons for yes/no/don't know responses).

In most cases, it is likely to cost more in terms of money, time and effort to develop, deploy and maintain a physical system compared with other methods, such as online surveys or tablet-based ones. *The assumed benefits, therefore, need to be clear.* Below, we outline a set of questions that are intended to help designers consider what the benefits might be for 'going physical' in terms of their requirements.

1. Is the goal to encourage more civic engagement with physical systems? Our study showed that using familiar, colorful and friendly interfaces for the boxes was able to draw passers-by in who then became engrossed in answering the range of questions. This was a first step in exploring civic engagement. Answering closed questions in this way appeared to be straightforward and people were willing to have a go. If more open-ended questions or people's opinions are desired then such a closed physical console approach might not be as appropriate.

2. Are high completion rates desired? If it is not important to have as many people as possible answering or only one person answering at a time, then a physical survey can be an attractive alternative to other methods. We were surprised at how many people answered and how long they were prepared to commit to providing information. The possibility that some people may not have realized that the boxes asked different questions could have led to them not going to other ones. Not wanting to wait until someone had finished at a box also could have been a deterrent. However, nearly everyone answered all the questions when at a given box.

3. Will the attractiveness of a retro design wear off over time (c.f. novelty effect)? Using bright colors for the physical boxes, making each one a different color and using old-fashioned tactile buttons, toggle switches and dials, were found to help attract people to the question boxes and find it easy and desirable to answer questions. The physical nature of the boxes also provides a nostalgic feel that may have also drawn people towards them. There is a concern, however, that the novelty of the design is attracting people and that having interacted with them once they would not do so again. We were unable to ascertain whether this was the case for this particular installation (although some people did come back to bring their friends/colleagues to have a go). To determine if people would 'tire' of using them for answering questions in different settings, would require such physical systems to be placed in museums, galleries, exhibitions, and other public places, and be designed for a variety of survey types – which is clearly beyond the scope of our research.

4. What are the benefits of using physical controls as input? An advantage of physically laying out the questions with accompanying toggles, sliders and buttons is it shows how many questions there are, and what is being asked of people as to how to answer. This can provide people with reassurance that it won't take too long and they can see how they are progressing through the questions. Another benefit of this form of physical design is that Sens-us can be repurposed to ask different sets of questions using the same input controls. The physical controls can also be designed so that they default back to a set position – that does not show the previous answer – if this became a concern.

5. Is it better to have several boxes to distribute the question sets according to themes or one central console with all questions? Having a number of separate boxes rather than, say, just one big box with all the questions [cf. 9] enables more people to answer them at the same time. It also means people can chose to answer all or just a sub-set, depending on the amount of time and interest they have. However, in situations where it is important that all questions are answered then this kind of set-up is not ideal. A walk-up kiosk where all the questions are cycled through via an interactive display would seems a better fit (although there is no guarantee that people will complete a digital survey if they see that there are lots of questions answer).

6. Should you guide people or let them explore the boxes by themselves? Making it clear that all boxes have to be visited and questions answered is difficult to achieve. It is well known that people rarely read instructions or follow signage/posters in situ. A design challenge, therefore, is how much flexibility to allow for – in terms of how and where questions are answered, versus how to design a set-up to encourage completion rate. It may be possible to design a really big box with all the questions on it – but that would be unwieldy to position in a room. Strategic placement of a set of boxes in a room that suggests a sequence of answering could help convey there is a set, but as our study showed it is not necessarily a strong affordance. Another possibility is to provide a set of smart cards to indicate that there is a set to complete (e.g. giving participants one card per box).

7. Physical systems enable a range of group types or individuals to use but what if you only want one person to answer them at a time? Sens-Us was designed to be flexible, allowing one or more people to interact with a box at a time. This encouraged couples, families and groups of friends to answer together and discuss their replies. However, in other contexts, it may be important to elicit responses from only one person at a time. Can a physical system be designed to restrict answering to only one individual at a time when part of a group? One way to constrain individual use is for the system to randomly ask a particular member of the group to answer the questions (e.g. the youngest, a female). The others could look on while that person answers. Another approach is that each member of the group takes a card and moves between the boxes separately (as we observed with some family groups) and then come together at the end to observe and discuss their answers at the visualization station.

8. What privacy concerns might there be when going physical? Sens-Us was designed to use two different kinds

of physical control in terms of feedback: one that left a trace from the previous answer by way of where it was positioned (the sliders, dials and toggles) and one that did not (the illuminated LED buttons). Our study showed that people were willing to input personal information regardless of whether the interaction mechanism persisted after they left so others could see or disappeared. The different types of controls used on the Sens-Us boxes, and their persistent or non-persistent natures, thus had minimal impact on people's willingness to share personal data in a public space.

9. Can providing real-time feedback trigger discussion and intrigue? When completing surveys, including the census, it is unusual to immediately have access to visualizations of the collected data. Our study showed that when feedback is provided in real-time it can be intriguing for people to find out more about themselves, triggering subsequent discussion. It provides an opportunity for people to reflect on how they differ from the norm and to make comparisons between themselves and others.

10. Where is it best to situate physical systems? Creating the feeling of a civic bureau worked well for enticing members of the public to come into the room and start entering information about themselves using the Sens-Us boxes. Placing them against a wall with some space between each provides sufficient personal space for people to interact with them without feeling uncomfortable or that other people were too near. Placing the visualization pillar in the middle of the room also provided a focal point for people to look at their data. Hence, the setting and how it is 'dressed up' is important in order to encourage people to walk up and interact with the system placed in it by their own volition.

CONCLUSIONS

The deployment of Sens-Us in a civic center has demonstrated how passers-by are firstly, attracted to, and secondly, willing to take part, unsolicited, in answering a range of personal questions. Our study showed how placing a physical survey system in such a public place was able to draw a diversity of people from different backgrounds. Its physicality, i.e. using actual switches, buttons and dials embedded in a colorful, waist height, console provided the affordances of accessibility, approachability and touchability – that literally played into the hands of the visitors. The boxes' inviting stance, together with the use of smart cards and real-time feedback, was both reassuring and intriguing. Moreover, privacy concerns were not an issue among those who participated. Our findings suggest that this kind of physical technology has much potential for offering a different and, perhaps, more open relationship between citizens and the state. Rather than view new technology in terms of how it can provide new ways of collecting data for a government to use, we have shown how it can be designed to encourage new forms of civic engagement where both citizens and governments can benefit from informing and being informed for the public good.

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