Designing and Making the Datacatchers: Batch Producing Location-Aware Mobile Devices

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ABSTRACT
In this paper we describe the Datacatcher, a location-aware, tangible and embodied mobile device that displays a continuous stream of statements about its location that are drawn from a large number of data sources and which speak to sociopolitical issues. We describe how the design and our underlying research interests emerged and changed over the course of three distinct phases of development: the device's conceptual design, its refinement to a final design, and the final detailing leading to batch production of 130 of the devices. We discuss the Datacatcher as resonant with many current issues in HCI, including augmented reality, environmental issues, political systems and using data as a design material.

Author Keywords
Design; research through design; batch-production; mobile device; location; Big Data

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

INTRODUCTION
In this paper, we describe the development of the Datacatcher, a tangible and embodied mobile device that displays data about its location drawn from a number of online sources (Figure 1). It was designed and built by our university-based research group, with funding from a successful EU research proposal. We trace the trajectory of the project from the background concerns that gave rise to the initial concept, through the process of refining the conceptual design, developing the hardware, software and product design, the batch production of 130 highly finished and fully functional research devices and their deployment to participants in a subsequent field trial.

In describing this project, we emphasise two perspectives. First, we offer the Datacatcher as an innovative design that offers an engaging interactive experience on its own terms, and moreover as a design that resonates with disciplinary concerns ranging from augmenting the physical world with online information to designing for political engagement [4], to questioning the value of digital devices vs. apps, to extending our understanding of environmental HCI. Here we offer the Datacatcher as a case study, an 'ultimate particular' [15,20] that embodies a constellation of stances with regards to these issues. Second, we describe the project as an example of research through design, responding to observations that the complex processes involved in designing devices should be better represented in the HCI literature [3,14,18,23].

In the following, then, we describe the project as a series of stages: initial conceptualisation, developing the concept to a design, refinement and production. Finally, we reflect on how our research intentions emerged over the course of design, and the lessons we learned in the process.

BACKGROUND AND INITIAL CONCEPT
The Datacatcher was developed as part of our long-term research, in which we take a design-led approach to developing new technological artefacts. We do not intend the things we make to become commercial products, but instead build them as *research devices* (c.f. [16]) that investigate new possibilities for technology, and that also help reveal peoples' values and practices in targeted

Figure 1: Two views of a batch produced Datacatcher

domains. In particular, the Datacatcher was the final design of a 5-year research programme concerned with exploring batch production and deployment as a method of pursuing a form of 'third-wave HCI' (c.f. [13]) that stresses the situated, holistic and interpretative nature of interactions with technology. The project was guided by two main objectives. The *domain objective* was to take a third-wave sensibility to issues of clear social importance (i.e., the Datacatcher was initially conceived as addressing environmental issues). The *methodological objective* was to explore the prospects for using batch production of hundreds of devices, and batch deployment to similar numbers of people, as a means to explore the diversity of interpretations, orientations and practices that might emerge, as this is a core interest of third-wave HCI.

From this perspective, the identity of the device we developed – what it was about – was shaped by our concern to explore socially important issues. At the outset of this project, we built on previous work we had done trying to extend notions of environmental HCI. Dissatisfied with the instrumental and prescriptive nature of many designs in the field at the time, and influenced by the critiques and arguments of colleagues such as [2,5,19,21] we had already produced designs to balance aesthetic and resource-oriented views of the home's microenvironment [10], to provide feedback about electricity consumption at a community level in the form of a graph painted directly on a neighbourhood street [1], and to gather and condense online discourse about energy-related issues as a way of reflecting and disrupting the understandings of a number of existing UK energy communities [11].

At the outset of this phase, then, our thinking was informed by a growing perception that, rather than conceiving and acting on environmental issues directly, it is important to understand them as continuous with, and a manifestation of, larger individual and cultural patterns. The development of this view on environmental issues also resonated with some of our more personal, 'lived' political concerns: about the inequality that cocoons the rich and exposes the rest, the lack of responsibility and sense of entitlement fuelled by an imbalanced access to resources, the surveillance and deprivation excused by invocations of terrorism and austerity, and the consumerist envy and egocentric thinking that goes hand in hand. From this (academically sketchy) perspective, our impact on the environment, and our seeming inability to ameliorate or even focus on it, is a 'natural' outcome of the sociopolitical patterns of our time. Thus a viable route for designing to protect the environment would involve pointing out evidence of inequality, consumerism, and so forth, with potentially explicit links to environmental measures.

This was the backdrop for a conversation between two of the team members in which the initial concept for the Datacatcher emerged. Discussing what might be useful for exploring environmental problems as a symptom of consumerism, one of us said something like: *"what would be fascinating is some kind of device that would let you see how much money people earn in the buildings right in front of you, and how much their homes are worth, and what kinds of environmental impacts they make."* This speculative notion marked the first beginnings for mining data to orientate local sociopolitical conditions.

CONCEPTUAL DIRECTION

Considering that research issues that we wanted to explore, we developed a fairly open brief for a design that would 'Provide politically relevant information (in some sense) in response to the device's location (in some sense) using web sourced data sets'. From this, then, the team engaged in intense exploration of ideas in the form of sketches, notes and conversations, exploring through and against the edges of the brief. We developed the most promising ideas in relatively systematic and considered – if often quite spare – treatments collected together in a series of design workbooks [6].

Over time, a brief for a device emerged as we settled on countless small decisions (or preferences) about how we would proceed. As a team, we felt a milestone was reached when we felt confident that the as-yet-unnamed system would:

- be handheld,
- use a black and white, e-reader-like outdoor legible screen, and
- have a battery that lasts days,
- eschew power hungry GPS in favour of GPRS cell phone technology to approximate location and to
- connect to a remote server providing data scraped from
- government sites, credit agencies, the UK census, Twitter™, Wikipedia™, etc, and
- allow participants to contribute their own opinions.

Form and affordances

By this point the team had already fabricated some test hardware using the .Net Gadgeteer platform [22], had evaluated a low-power Sharp memory LCD screen (a larger version of that used in the first generation Pebble watch [17]), that was to be used in the final design, and investigated batteries capable of powering the device for requisite periods of time, so we had a fair idea of the packaging requirements for a device. This allowed the team to explore dozens of eventual configurations, which led to speculations about how the device might be used (At home? Carried by hand? Mounted on a car dashboard? Attached to objects by a built-in strap? Perhaps left in a public space as a form of electronic graffiti?). Figure 2 shows a small sample of the sketches produced around this time; the co-definition of form and anticipated uses continued through to the final specification of the device.

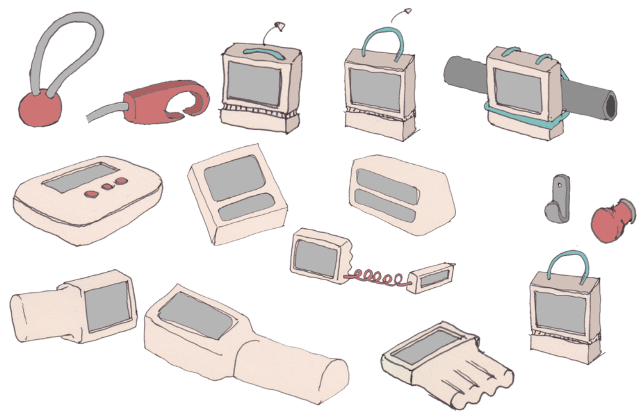

Figure 2: sketches of possible forms

Data, Treatment and Voice

We decided fairly quickly that the system would scrape existing information from the Internet, similarly to previous designs we had produced [7,8,9,12]. Now we set about exploring a wide range of sources for sociopolitically relevant information. For example, the team collected every scrap of public data for a given postcode in London, gathering information about poverty, energy prices, test results, population and demographics, house prices, businesses, historical figures, events tweets, MP activity, meetings, blogs, news, gang activity and songs which mentioned the place. This was useful in gauging available information and assessing valuable sources.

Two issues arose in the process. First, data sources define 'location' at different resolutions and with overlapping boundaries, raising the question of how we could indicate what 'here' means. Second, most sources take the form of databases that return numbers or short phrases in response to queries, and we wanted the device to display natural language outputs. We started to explore how this might be achieved by simulating sentences and trying cut-up techniques to explore possibilities for algorithmic production. We also started to experiment with different 'voices' for the system, ranging from brief summative 'area glimpses' to formulations which were optimistic or complaining, and considered 'curating' the tone of outputs to, for instance, reflect stock market movements.

Interaction and Participation with Data

Another line of thought concerned moving the experience beyond passive reception of information towards more active involvement. For instance, a recurring idea concerned a 'significant moment' button that would allow people to tag messages they thought interesting, perhaps for broadcast to other devices or to allow later review. Similarly, 'less-like-this' and 'more-like-this' buttons might allow people to shape the sorts of information they received or perhaps request more detail.

Over time, these ideas settled into two new modes for the device. First, we decided that people should be able to scroll through the history of previously received messages, allowing them to review a timeline of information about areas they had been. Second, we formulated a series of 20 questions and multiple-choice answers that people could use to register and share their opinions of the local area, with the results added to the corpus of content available to the devices.

Changing Conceptual Direction

As the project progressed, the conceptual direction for the design of the device evolved. Our initial motivation was to build a system that would illuminate how environmental practices are entangled in sociopolitical issues such as inequality, privilege and consumerism. As we explored the design space, however, this began to shift. To begin with, we were influenced by the availability of data as a design material. In exploring what we could find about specific areas, it became clear that while some environmentally relevant data was available (e.g. about energy consumption, sources for heating, pollution levels), this was overwhelmed by information about other topics (income, housing prices, crime). Conceptually, we were enthusiastic about providing a broader view onto the sociopolitial realities of local neighbourhoods as relevant for thinking about issues beyond the environment. Thus the Datacatcher evolved from an environmentally-centred design to take on a broader sociopolitical ambit.

Second, as we began to explore the large corpus of datasets from private and public bodies that tag and categorise location, we began to become increasingly interested in Big Data as a subject of interest in its own right. We discovered, for instance, that credit rating agencies have classified each household in the UK with one of 64 categories that predict who they vote for, the newspaper they read, the car they drive, their career prospects and their disposable income. We saw how health statistics reveal that life expectancy can vary drastically from London borough to borough, and indicate areas where people don't eat enough fruit and vegetables. It became clear that as a material for design, data is never neutral, but always reflects assumptions and motives that themselves can be seen as political. This raised questions for us about how Big Data represents us, and about whether a tension might exist between how this data represents local populations and how people might understand themselves. Thus we saw the Datacatcher as implicitly raising issues about data, as well as about the sociopolitical textures of the UK.

MAKING: REFINEMENT AND PRODUCTION

As our work converged around a set of common ideas and decisions, the project shifted towards implementation as we our efforts turned towards constructing a working system – the data mining and processing, the device electronics, the form and interaction design. This shift was also marked by the choice of Datacatcher as name for the device, which both summarised our thinking and helped guide development.

The Datacatcher was a challenging device to produce in low (hundreds) volume. We faced innumerable issues and challenges in bringing together the electronics, software, housing design and interactivity, and a full account of this process would be lengthy, confusing and tedious. In general, however, the first emphasis was on the data that it was to display, the second on the electronics and software that allowed it to do so, and the third on the design of the housing for the emerging behaviour of the device.

Sourcing and Presenting Sociopolitical Data

Through our experiments mining localised data, we settled on a total of fourteen different online and offline UK sources, many of which provided dozens of separate data sets, to give us access to hundreds of individual data streams for use by the system. Data from public bodies like the Office for National Statistics, the Department of Energy and Climate Change, and crime statistics from the police were supplemented with commercial data from Twitter and property index site Zoopla. Several sources, such as data from the credit agency Experian, were available to us only because we work for a university.

Server-side code translates data returned by these sources into meaningful and legible sentences for delivery by the Datacatchers. For instance, health-ranking indices for different postcodes were turned into messages such as '*The census shows that 25% of people around these parts are smokers*'. Each of these translations is built around a crafted sentence structure that accepts an automatically inserted variable. In total, there are there are around 600 individual template sentences for each UK postcode. Many of them sought to draw attention to the agencies behind the data, for instance by starting sentences with "they say", as in "they say people around here are not happy".

Determining Location and Transferring Data

The design of the Datacatcher's hardware is similar to a GPRS phone, handling connectivity to a server to provide cell information, receive messages, and send any answers to poll questions. Each device connects to a local cell phone tower, opening a GPRS connection to the server that queries the location of the tower ID which is used as a proxy for the device's location.

The Datacatcher server preforms all of the system processing – e.g., data mining and sentence construction. We have used a similar approach in previous designs (e.g. [8]), but instead of supplying content to one or a few devices, the Datacatcher server generates hundreds of individual feeds that react in real time to location changes. This was a significant challenge, the scale of which was difficult to appreciate at the outset but required considerable expertise to implement reliably.

Product and Form Sketches

The form design evolved alongside technical development. Figure 3 shows a small sample of the dozens of form studies and models that we produced. The left panel shows a selection of early models, in which we pursued early concerns with different usage scenario including, for instance, ways of attaching the device to others, or possibilities for tabletop versions, and even a version in which the screen is mounted within a mirror to emphasise the data's link to the surrounding environment.

The designs on the right, in contrast, reflect refinement much later in the cycle. At this point we had decided to mount the screen on the end of the device, so that in use attention would be on the content rather than the object. The physical size of these form studies increased as we began to appreciate the power requirements of the system, gradually increasing battery capacity in each iteration. The figures also show the evolution of a cutout section, originally conceived as a means of attachment, to eventually become a recess for the control dial and space to hang the device on the thumb.

A Handle for a Battery

We investigated several different options for powering the device. We hoped to use a small and light power pack, but also wanted the device to last days on a single charge. We discovered the modem demanded a 1.4A current whenever

Figure 3: Evolution of the Datacatcher's form. Left panel shows early explorations, right panel shows convergence on final form.

we opened a GPRS connection (frequent due to code glitches), so we decided to use a large power cell with around four times the capacity of a smart phone. Our first form designs were of a similar size to a pager, but the chosen battery was bigger than initially anticipated, so the form evolved and a handle was created to house the power unit. Some observers have compared the final design to a torch (US 'flashlight'), however the intention is not to create a pointing device, but rather to allow the bulk of the battery and electronics to disappear behind the screen so that, in use, only the messages appear to the viewer.

App vs device

Of course, our considerations of form would have been rendered irrelevant had we decided to produce the design as an app. This question was often raised during our development cycle, but there were several reasons why we considered that a standalone device would be superior. Overall we felt the design would best work conceptually as a system that would continuously collect data as it is carried around, and we wanted to avoid having our design compete for attention, screen space, processor and battery power with other apps that sit in a landscape of iOS/Android mediated entertainment, lifestyle or wayfinding systems. Designing the device also allowed us to investigate different affordances, aesthetics and cultural connotations, than would be possible in an app housed on a smartphone or tablet mediated by consumer operating systems.

In addition, while an app could be distributed to thousands, our ambition was build a system for around a hundred participants whose experiences we could manageably observe. It was therefore advantageous to technically ring fence the system hardware. For our small team, building a server that could reliably talk to a few hundred identical devices was just about possible. Developing an app to run on a multitude of versions of different operating systems (and future updates) would have been more resource intensive, not only during development, but also through the field study and in any future uses of the system.

Finally, many of us felt that the endless landscape of similar-appearing apps is flattening and uninspiring, and wanted to explore and indeed insist on the continuing viability of stand-alone computational products in the current technological landscape.

Technical Description:

The Datacatcher uses an entirely bespoke electronic design. It was prototyped and developed using modules from the .NET Gadgeteer platform [22], which were later rationalised and combined onto a single board that is based on the architecture of the open source GHI Electronics FEZ Cerberus Mainboard. The Datacatcher's PCB measures 100 x 40mm and its main features include an ARM 32bit 168MHz STM32F427VIT6 microcontroller and a SIMCom SIM900 quad-band GSM/GPRS module, with battery management and charging utilising the Maxim MAX1508 chip. There are two Gadgeteer sockets for two peripherals: a rotary encoder (Alps EC11J) and display unit. The screen is a 2.7-inch memory-LCD display manufactured by Sharp (LS027B7DH01) with a resolution of 400 x 240 pixels.

The footprint of the PCB was broadly based on that of the rechargeable battery, a Panasonic PA-L46 lithium-ion. This is a large unit (in comparison to say two AAA cells) that occupies much of the Datacatcher's physical volume but outputs 4500 mAh at 3.6V, which is enough to power the device for several days of continuous use. Cell phone radio is handled by the FXP.07 quad-band GSM flexible PCB antenna manufactured by Taoglas. Data service is provided by a machine-to-machine SIM capable of roaming across different UK carriers for the strongest signal. Each Datacatcher connects to an Amazon web server that utilises the Google Maps API to geo-locate the cell tower that the SIM is connected to, information which is used to build a feed of local data that is delivered back to the device in messages groups of 20. The server-code was written in JavaScript using a service oriented architecture consisting of multiple node.js processes communicating via Redis.

Thumb Dial Interaction

The interface for the Datacatcher is via a thumb dial (figure 4) which interfaces all the devices functions. The dial is attached to a 20 step rotary encoder which includes a push down switch. The default mode of the Datacatcher is to display messages, paged individually to the screen every eight seconds (see figure 5 for example screen modes). Rotating the dial anti-clockwise from this default mode enters the timeline, where all previously collected messages can be viewed chronologically. In this mode, additional metadata surrounds the original message that identifies the location, time/date stamp and message source. Clicking the thumb dial holds the historic message on screen indefinitely, otherwise the Datacatcher springs back to the default mode after a period of no interaction. Spinning the thumb dial quickly in timeline mode accelerates scrolling through the history, ensuring that it is relatively easy to navigate to a particular time point.

Rotating the dial clockwise from the default mode enters the poll question mode. Once this mode is entered 20

Figure 4. Datacatcher Thumb Dial

questions (see Table 2) about the local area can be scrolled through left and right. Clicking the thumb dial again when viewing a question reveals a set of multiple choice answers, which can also be scrolled left and right. Clicking again confirms an answer, otherwise the display springs back to the main questions. Answered questions are returned to the server and enter the corpus of data that may be delivered back to a Datacatcher in the same location at a later time (phrased appropriately for ownership 'earlier you thought … here' or 'someone previously thought… here') As with the timeline, after a period of no interaction the Datacatcher will return to the default message mode.

Physical Construction
The Datacatcher casing is constructed from two nylon components made via additive manufacturing using selective laser sintering (SLS). These parts are an internal chassis that includes the display bezel and an outer sleeve that forms the skin of the device. The majority of components including the screen, battery, antenna and PCB clip into the internal chassis, whereas the rotary encoder is secured by two self-tapping screws for strength and reliability. The assembled chassis slides into the outer sleeve, which locks shut with a clip and there is one self-tapping screw to prevent these two parts detaching. The push-fit dial is also made with SLS. It attaches to the Alps encoder and is locked in place with cyanoacrylate glue.

Batch Production
Our team is experienced in making technically sophisticated research devices, yet producing 130 high fidelity and robust devices raised some challenging issues. It was a method that involved many people, materials and processes, and the sheer scale introduced problems that we had not envisaged or encountered before. Our solutions to these issues further shaped the Datacatchers' eventual identity and, ultimately had effects on the way our research played out.

For instance, our choice of the manufacturing technique used to produce the case had decisive effects on the device's eventual form. We considered using injection moulding, but that would have made the cutout section we had been developing impossible to achieve. Instead we chose to use additive manufacturing as that allowed dramatically different possibilities for form design. Even here though, however, the particular manufacturing technology used turned out to influence the design, and it took a great deal of work (including specifying the exact orientation of each part during printing) to achieve the same fit and finish we had with prototypes built on our own fused deposition modelling (FDM) machine on the SLS machines used by the contractor we hired to batch produce them.

A simpler but more dramatic effect was made when we discovered that a crucial component of the devices was in short supply. We had decided early in our design process to use a particular memory-LCD part (Sharp LS027B7DH01) for the display, because of its resolution, legibility and – importantly – its low power requirements. But when we came to order the planned 250 units, we discovered that Sharp had sold out and were not planning to produce more for months. This led to a worldwide search for the last remaining units, but even so reduced our planned production of Datacatchers from 250 to an eventual 131. This didn't affect the realisation of the devices itself, but it did impact on the scale of and plans for the field trial.

The Emergence of the Datacatcher
Over the course of figuring out how to make and ultimately batch produce the Datacatchers, their specific identity became fixed in detail. From the space of possible forms and use scenarios explored through the models on the left of Figure 3, the final design emerged. Along the way the identity of the device coalesced, shifted and sharpened under a large number of influences.

One of the major influences on the Datacatchers' evolution was our increasing focus on making the Datacatchers' aesthetically appealing and engaging in their interaction. Arguably, this is irrelevant if we think of the device narrowly as a way of only exploring our domain objectives. But this was crucial for a device that we would ask people to use for extended times in their everyday lives: we couldn't rely on them to share our research interests, but instead had to produce devices that would be rewarding in their own right. Our concern to achieve an appealing design impacted every aspect of the design development, shaping the devices as much as our intentions to expose issues of sociopolitics and big data did.

Thus our initial research concerns and the desire to produce an engaging design joined to shape the Datacatchers. But many other factors played important parts. As we have described, these included technical issues ranging from the capacity of batteries to print orientation of parts. They also included the nature of data available, and the resolution of that data both geographically and in time. Moreover, many other design details resulted from our engagement with infrastructures, networks, data and materials. The UK cell phone network, Google Maps Geolocation API, data licensing, postcode revisions, global supply chains, database formats, nylon dyeing methods, University lawyers, UK mail regulations for lithium batteries, quirky cell phone hardware: these all had impact on details of the final design and interaction. In many respects the final design is a result of thousands of small decisions that work around problems and issues [20].

These influences did not simply constrain or compromise our initial concept. They also suggested new possibilities and led the design in new directions. Notably, the decision to use additive manufacturing to produce the Datacatchers' housings allowed a form design that would have been difficult or impossible to achieve in other ways. The sheer scale and scope of data available led us to expose a range of topics and to create flows of messages in a far more flexible way than we had anticipated. As the Datacatcher evolved, then, so did our understanding of what it could be.

DATACATCHER: TANGIBLE INTERACTION WITH COMPLEX DATA

Figure 5 shows Datacatchers displaying a variety of live and historical messages as well as a few of the poll questions. Once switched on, the Datacatcher displays user instructions while it connects to the cellular network and server. In its default operation, it streams messages about its local surroundings at the rate of one every eight seconds. Turning the dial anticlockwise scrolls through previous messages, and also shows the data sources (e.g. 'UK Census') and the location and time they were displayed ('Greenwich, 14 November, 15:42'). Turning the dial clockwise accesses a series of poll questions that can be answered by scrolling through multiple-choice options and selected a response with by clicking the dial. Table 1 shows a few of the hundreds of potential messages presented by the devices, and some of the poll questions and possible answers are shown in Table 2.

DISCUSSION

In this account, we have exposed the complexity behind the Datacatcher's seeming simplicity. Technically, we believe this is of interest to other small teams seeking to produce sophisticated systems. Our team is experienced in producing low-volume runs of embodied devices, but the Datacatcher was extremely challenging: We batch produced devices in numbers far greater than we have attempted before. The server handles far more data sources than any other system we have built. It talks to more devices than any server that we have constructed previously.

Conceptually, the Datacatcher is equally complex. As we have described, it emerged from considerations of environmental problems and orientations, of sociopolitical issues in current society, of locative media and of apps vs. computational products. It was enabled by the availability of data to illuminate some of those issues, and conversely raises questions and doubts about how Big Data is collected and used to represent communities and individuals. Bringing together all this complexity to produce such a simple-seeming device is, we suggest, one of the achievements of the Datacatchers' design.

Field Study – Giving Away 130 Devices

Our emphasis in this paper has been on the design process that led to the Datacatchers. A full account of the field trial that followed is available in another paper [12]; here we briefly summarise its highlights.

We employed a commercial design consultancy to deploy the devices to volunteers recruited at street markets, and hired two teams of documentary filmmakers to capture participants' experiences in a collection of short documentary films which are available to view on a Vimeo channel [24].

Source	Message
Census	The census says that 10,300 people in Lewisham are unemployed.
Experian	They say residents in Deptford have smaller carbon footprints than nearby in East Dulwich.
National Archives	Low level of happiness around here
Police	941 crimes in July
Fix My Street	"Dog fouling in the mornings" is a local issue
Zoopla	A 6+ bed house will cost £9,794,000 to buy
Experian	A credit agency says people who live in the vicinity are young, well paid, mostly single professionals, who have chosen flats suitable for commuting to urban Jobs
Census	43% of people in this community are White.
Participant Poll	9/10 of us were happy in this location recently
Wikipedia	Deptford Market, a street market in Deptford High Street sells a range of goods, and is considered one of London's liveliest street markets.
Google	More places of worship here in Deptford than nearby in Southwark.
Participant Poll	3/6 of us described poverty we were recently as "growing".

Table 1. Sample Datacatcher sources and messages

Sample Poll Questions and Answers
What are the dogs like here? *handbag / working / family / weapons / fighting / blow-dried*
How do you feel here? *scared / unsafe / on guard / comfortable / secure / nannied / smug*
What is the air quality like? *mountain fresh / good / poor / toxic*
What are the politics around here? *friendly fascist / neo-liberal / weekend radical / anarchy rules / not bothered*
Are the buildings here? *chocolate box / social / brutal / imperial / fascist / innovative / faux*
Poverty here is? *endemic / growing / hidden / nowhere / frowned upon*
Around here, the revolution will… *start /pass through / avoid / miss / be televised / be quashed / overturn everything*

Table 2. Sample poll questions and answers

Participants Impressions

Most participants expressed positive impressions about the the Datacatchers' design: 'Absolutely everybody who saw it was completely intrigued by the design, the shape of it and stuff… it is a really beautiful design…' (participant 102). This extended to the aesthetics of interacting with it: 'It's really satisfying when you use the wheel, because you get that lovely clicking feel… as opposed to just flicking through a bunch of messages' (p019).

Participants reported that the Datacatcher's design often prompted social interactions with bystanders: 'It immediately gets people asking questions.' (p026). As one participant explained: 'People around the office were kind of like, "Wow, what's that? Is this like a toy? What is this device?" So the design, the colour, the shape, that was quite a good talking point' (p009). Moreover, what started as discussions about the Datacatcher's appearance would often merge to conversations about the issues it raised: '…so in a group we had discussions around "Is this useful or is this just an interesting fact? Or what does this mini survey tell us about the area?" So it was a great, I think the social value, the entertainment factor was great' (p035). In part, such discussions were valued as drawing attention to rarely discussed issues: 'You start discussing the facts and it brings you to bigger issues in the area that normally in your day to day life are not really brought to attention' (p065).

In sum, participants' responses indicated that the Datacatchers successfully raised many of the issues we intended, and were appreciated in their own right as well.

Conclusion

The Datacatcher was successfully manifested from a complex set of ideas and design challenges. Moreover, we believe that the many conceptual issues that we addressed in its creation can be discerned in the final device itself. The data sources we chose provide environmentally relevant information, for instance about the sources of energy people use at home, or the modes of transportation they use, or local pollution levels. They also provide information about sociopolitical issues, including local income levels and housing prices, educational achievement, access to healthcare and ethnic makeup. Viewing the device while travelling, or revisiting messages by scrolling through the device's history, effectively reveals the very different sociopolitical backdrops of peoples' lives. Finally, by revealing the sources of the messages, and through the use of phrasing, the device provides resources for beginning to appreciate the extent of information held by Big Data, the ways it represents people, the questions it asks and the ways it couches its answers.

At the same time, a Datacatcher is not a set of ideas, but a physical device. It has weight in the hand, and a solid feel that gives it a kind of presence. It is, in Nelson and Stolterman's terms, the result of 'a process of moving from the particular, general and universal to the *ultimate particular* – the specific design' ([15] p. 33). Artefacts such as a Datacatcher are ultimate particulars because they are *real*. None of their details are unspecified or left to the imagination; they are fully resolved, perhaps the only undeniable fact to emerge from our design research [20].

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Figure 5. Clockwise from top left: start up screen, live feed messages from the NHS, the Environment Agency, credit agency message stored in the timeline, Participant Poll broadcast and Participant Poll question.

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