

Designing from, with and by Data: Introducing the ablative framework

Chris Speed*, Jon Oberlander

Centre for Design Informatics, University of Edinburgh

* c.speed@ed.ac.uk

Abstract: This paper introduces a framework for designers in which existing methodologies can be placed in order to better acknowledge how they work with data in different ways to support their practice. The paper starts by distinguishing three kinds of value associated with data: (i) raw measurements; (ii) commercial and social; and (iii) moral and ethical. We then note that changes in computing and communications technologies serve to de-emphasise computers as devices, and re-emphasise the flow of data between people, machines, and things; thus, we share the view that human-data interaction is a key challenge for designers. In addressing the challenge, we introduce the framework for designers to distinguish design *from*, *with*, and *by* data. We note that informatics provides the theory for, and technologies of, information processing, while design provides the methods to adapt and create products and services. The paper uses case studies to illustrate our approach.

Keywords: design, data, informatics, framework

1. Introduction.

Design has used qualitative and quantitative data to inform the development of products, services and systems for many years. From market analytics to observational analysis, and questionnaires to design probes, designers understand implicitly the need to watch, listen and learn from the data that is gathered by prototypes before and during the design process. However, whilst the methods for gathering data have grown to reflect research through design approaches, there has been little classification of the kinds of data that we are encountering in an age of big data, nor to frame how we design alongside it.

This paper introduces a framework for designers to reflect on their existing methods of working with data, in order to anticipate its ability to transform design process as its level of performativity increases. The paper begins by outlining three kinds of value that data is involved in mediating and then establishes a complexity in which qualitative and quantitative data becomes entangled across social, economic, moral and ethical values. The second part of the paper introduces an emerging field of enquiry that supersedes Human



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/).

Computer Interaction, that of Human Data Interaction (HDI). HDI demands that serious attention is now required to address the systems that place stress on conventional ethical and moral models of handling personal data. Our paper takes this mantle and proposes that designers play a vital role in the design of future systems in which people, things and computers co-exist in the production of data.

However, in order to understand better how to design alongside data, the authors go on to introduce a framework for recognising how existing and emerging research methods address the increasing performativity of data. The paper closes with reflections on the three cases of designing from/with/by data, and then explores the implications for the framework.

2. Data involves at least three kinds of value.

A collection of data can be thought of as a set of values for some variables, acquired originally by measurements of some kind. Under an appropriate interpretation, data counts as information, and information processing can refine (relatively) raw data and make it useful, by capturing, transforming and communicating it.

In the past, and still today, almost all data is impersonal; measurements in the Large Hadron Collider, or in the Square Kilometer Array aim to provide extraordinary numbers of values for variables every day. Of course, in the past, at least some data was personal, as in population censuses. However, an increasing amount of data is personal. That is, because their preferences, attitudes and behaviour can be measured online in many ways, people nowadays generate lots of data, both consciously and unconsciously. This “big data” of a personal nature captures aspects of their behaviour as consumers, communicators, and as healthy or unhealthy physical and social beings.

So the first set of values, the data values that are mere measurements, can become entangled with two other important kinds of value.

The second kind of value arises because by aggregating any kind of data at scale, corporations and agencies can generate new commercial or social value: they can create products and services which increase individual or collective utility, and which can be monetised in at least some cases.

The third kind of value arises because the ways in which corporations and agencies treat all kinds of data (but especially, personal data) reflects a set of moral or ethical values, including: the protection or violation of privacy; the promotion or prevention of reciprocity in relationships; respect or rejection of the customs and attitudes of less powerful peoples—such as their attitudes to time, diet, or sexuality; and the enhancement or erosion of fairness in societies most generally.

3. The fall of computers and the rise of data

The pervasiveness of the internet, and of wireless networking, have enabled widespread adoption of cloud computing services. For our purposes, what matters about the cloud is

that it opens up gaps between the places where data is generated, processed, and acted upon. In the past, the capture, transformation and communication of information might all have happened in one place on one material device: a computer with suitable peripherals. Now, we frequently do not care where the computing takes place. In light of this, some aspects of human computer interaction are better framed in terms of human *data* interaction. If human computer interaction studies the ways in which humans interact with, and through, computers, we might now de-emphasise the material devices doing the computing, and focus more attention on the ways in which humans interact with, and through, data.

One group of researchers concerned with the processing of personal data have already used the term “human data interaction” to cover the “the individual and collective decisions that we make and actions we take, as users of online systems, or as subjects of data collection practices” (Mortier et al. 2014). They point to the need to “make data and analytics algorithms both transparent and comprehensible to the people the data and processing concerns”, and to give people “the capacity to act within these data systems, to opt-in or to opt-out, to control, inform and correct data and inferences”. On this account, the proper study of human data interaction goes well beyond traditional interests in data visualisation, to explore social, legal and ethical aspects of personal data processing. Thus, the three kinds of value introduced above are all implicated.

But two other trends relating to data and interaction are worthy of note. The cloud accelerates the harvesting of personal data, to be sure. But it also enables other new data flows, through both the Internet of Things, and systems which support social computing. The Internet of Things (IoT) is “the set of technologies, systems and methodologies that underpins the emerging new wave of internet-enabled applications based on physical objects and the environment seamlessly integrating into the information network” (UK Internet of Things SIG Roadmap, March 2013). Social computing is where social behaviour meets computational systems. It encompasses current online social interaction, but also generates people-powered computation, with applications from online auctions to recommendation systems, from election monitoring to citizen science.

Mortier et al.’s concept of human data interaction is focussed on personal data, and the problems and needs associated with it. The IoT and social computing introduce at least two new options. Consider the IoT. First, we need to interact with data, and perhaps we can use things to help us do that. But secondly, we will sometimes need to interact with the things themselves, and we will therefore likely need to transform IoT data into forms with which we can interact. Thirdly, any new interaction with data or things can itself generate further data, given suitable instrumentation. Finally, it would be natural for levels of access to depend upon on the roles individual actors play with respect to collections of things. In these respects, social computing is analogous: people can use social computing systems to interact with data; they can use data to interact with the systems; their interactions generate further data; and what they can do will depend upon their role in the larger system.

Drawing these points together, we see that they are simply facets of a world of distributed computing in which the cloud helps separate the physical mechanisms of sensing, storing, processing, communicating and acting upon information. Some mechanisms are local, others remote. Some mechanisms are obviously computers, others look just like things, and yet others are people. This picture multiplies the numbers and types of agents at loose in the world, but it is obvious that all the data flows and information processing are still entirely supervenient on physical mechanisms. But some of the mechanisms are out of sight of the people involved in the data flows, and so it is quite understandable that they distinguish the material, visible things from the immaterial, and sometimes invisible data flows.

Some of the data which people interact with can be considered “research data”, in the sense that it is collected to inform the design of products and services; at the same time, sometimes data (big or small) is itself a major part of a product or service. In the former case, the main people interacting with data are designers; in the latter case, it is end users who do most of the interacting (thanks to the designers). So data plays multiple roles in design research. Moreover, the problems of human data interaction identified by Mortier et al. are important, but they are not in fact specific to personal data; they apply also to the other data flows, including those involving IoT data, and social computing data. This being so, how can these problems be tackled by designers of future systems of people, things and computers?

4. A framework for designers

With an established history in the development of creative methods toward the gathering of empirical data, designers have made significant contributions to how quantitative and qualitative data support a more user-centred design of products and services. However the advent of mobile and ubiquitous computing presents the discipline with a more complex array of data forms that are mediated in different ways and as such, they demand that we think about how designers design around data. In looking for a means of distinguishing between the forms of data that designers are now faced with engaging with, the authors identified an increase in the performativity of data. From types of stable data that remain immutable, through data that is transformed with the networks that it is associated with, to data that is beginning to produce its own data, there is a continuum in which data begins to speak for itself (Cox 2014). Performativity is a complex term that Dewsbury describes as “the gap, the rupture, the spacing that unfolds the next moment allowing change to happen.” (2000), and traditionally performativity is used to explain the capacity of speech and gestures to act and offer emergent structures. The term is attributed to the language philosopher Austin who established that words can be used not only to describe something, but can used to do something. His most poignant example of what he coined as ‘performative utterances’ being when we use the words “I do” to instantiate an action (such as marriage) (Austin 1962).

Acknowledging that data is starting to 'do' things, we turned to the ablative case in Latin that indicates an agent, instrument, or source within a relationship expressed by 'by', 'with', or 'from'. If designers are having to adapt to how they derive knowledge through data, the ablative case might best describe how the data that they are working with is increasing in its performative qualities. By reversing the traditional ablative case in which 'by' is given agency, 'with' is co-produced and 'from' is taken, it is possible to express the shift in practices that designers have begun to develop as data moves from being something like a source to design 'from', to a complex and fluid setting to design 'with', and finally to a condition in which design is produced 'by' data itself.

4.1 Design from data

Design **from** data: when systems are designed by people, where they are inspired by measurable features of humans, computers, things, and their contexts.

There are many methods that designers use to elicit data from social, technical and environmental settings: from established ethnographic methods from user observations (Abrams 2000, Stempfle 2002 and Kawulich 2005) and interviews (Bernard 2000, Byrne 2001, Rubin 2005); to more designerly methods including cultural probes (Gaver et al 1999), technology probes (Hutchinson 2002) and Contextualmapping (Stappers et al 2005).

Criticised by Norman if solely used at the beginning of a design process (2006), user and participant observations help designers gather data from people in specific situations. From 'fly on the wall' approaches to the use of video, still photograph and note taking, the gathering data from contexts in which people are carrying out everyday practices or using prototypes, is a familiar method for designers to understand social practices. Similarly, the use of structured, semi-structured and un-structured interviews also offers a valuable method to gather data about the perceptions, behaviour and opinions of people who are engaged in the consumption, use or interaction with particular products and contexts. Whilst participant observation and interviews are extended from established ethnographic methods, cultural probes and context mapping are more unique to design and use artefacts and materials to gather data. Packs consisting of various elements such as diaries, disposable cameras, postcards and drawing materials that are distributed to project participants, encourage them to describe their experiences without the presence of the design researcher. Use of graphics, metaphors and personalised touches can support participants to offer imaginative material to inspire the design process. In the development of technology probes, Hutchinson et al. acknowledge how "probes will change the behaviour of our users" (2002) and subsequently developed a probe that uses technology to foster a co-adaptive relationship with the user in which the device provokes and promotes interactions from which understandings of use and context can be elicited. Explicitly not a prototype, technology probes stimulate use over a period of time, and allow researchers to reflect on this use in order to gather information about the users as well as inspire ideas for new technologies. Contextmapping, also a design technique, uses a series of phases that begin

with the capture of the designers' preconceptions for a setting, followed by the use of a variety of stimuli (including questions and cultural probes) to help participants reflect on a circumstance or situation. Sessions are usually recorded to support the identification of patterns in language, experience and practice.

The variety of methods for gathering data is not limited to the four examples above but extends to all processes in which data is gathered 'from' settings before being analysed and used to inform subsequent design decisions. Through the multi-disciplinary Equator project, a good deal was established about the appropriate ways that data can be gathered and used to inform design. Hemmings et al. list seven steps toward design: 1. Planning; 2. Recruiting Participants; 3. Selecting Volunteers; 4. Assembling Domestic Probes; 5. Deploying Domestic Probes; 6. Retrieving and Analysing Probes, before 7. Speculative Design (2002). This order of data capture ultimately ends in the studio, where the designer can learn and design 'from' the materials.



Figure 1 The Hagggle-O-Tron was developed using a combination of design from data methods including video ethnography and participant observation through the use of a technology probe.

An example of how the authors have developed a Design From Data approach is in their development of the Hagggle-O-Tron (Speed et al 2014). The Hagggle-O-Tron is an interactive kettle that was developed for placement within an Oxfam secondhand shop to explore how haggling (a practice currently prohibited in Oxfam shops) might be helpful in revealing secondhand goods' financial, moral, social, and aesthetic properties. Visitors to the shop

were invited to use the kettle to haggle over the price of an article that they were interested in buying. A member of the design team who was located in the shop's backroom and was connected to the Hagggle-O-Tron via a web camera and microphone. This 'Wizard of Oz' technique allowed us to simulate the kettle's sentience, in order to sustain a realistic haggle. From reviewing footage and identifying interactions back in the studio, the researchers gained a better understanding of bargaining tactics, the use of incentives and the effective vocabulary that would support Oxfam's wider charitable projects, whilst offering them an insight into how they might change their in-store policies.

4.2 Design with data

Design **with** data: when systems are designed by people, where they take into account the flows of data through systems, and the need to sustain and enhance human values.

As the network society has developed, ethnography in turn has developed means of expanding its practices to utilise social media, telecommunications and internet communications in order to gather data. Virtual ethnography (Hine 2000), netnography (Kozinets 2006), cyber-ethnography (Keeley-Browne 2011) and online ethnography (Wilson 2002) all refer to online research methods that have adapted traditional ethnographic methods to study participants through computer-mediated social interactions. Whilst these methods largely gather material and report 'from' sources before analysis, easy access to ubiquitous computing technologies is enabling researchers to sustain a link 'with' a participant or community to better understand how data-centric prototypes, products and services have an impact on the user. We describe this emerging research scenario, in which information can flow in more than one direction, as one in which it is possible to 'design with data'.

The constant connection to the internet between products such as smart phones or services such as energy through smart meters in homes, is transforming the industry of design. No longer are designers simply contributing to stages in a value chain as a product moves from manufacture, packaging, distribution to consumption; designers are retained to mediate the value of products and services within a complex network of social and environmental connections. Coined by Normann and Ramirez (1994), the term 'value-constellations' describes the economic systems that emerged at the end of the 20th century as globalisation and new technologies influenced the way that value was sustained. Recognising the role of co-created value within networks, Normann and Ramirez highlight that "successful companies conceive of strategy as systematic social innovation: *the continuous design and redesign of complex business systems*" (1994). Within a value-constellation, the value of a service is constantly mediated according to the flows of data that allow users and stakeholders to sustain the value proposition associated with a product, service or experience. These more dynamic models of value creation and relation represent a different opportunity for design to retain a relationship with users throughout their engagement with products (Speed & Maxwell 2015). The opportunity for designers to

‘design with data’ that is derived from the interactions of users enables a different understanding of how the feedback from user communities affects the value of a product or service.

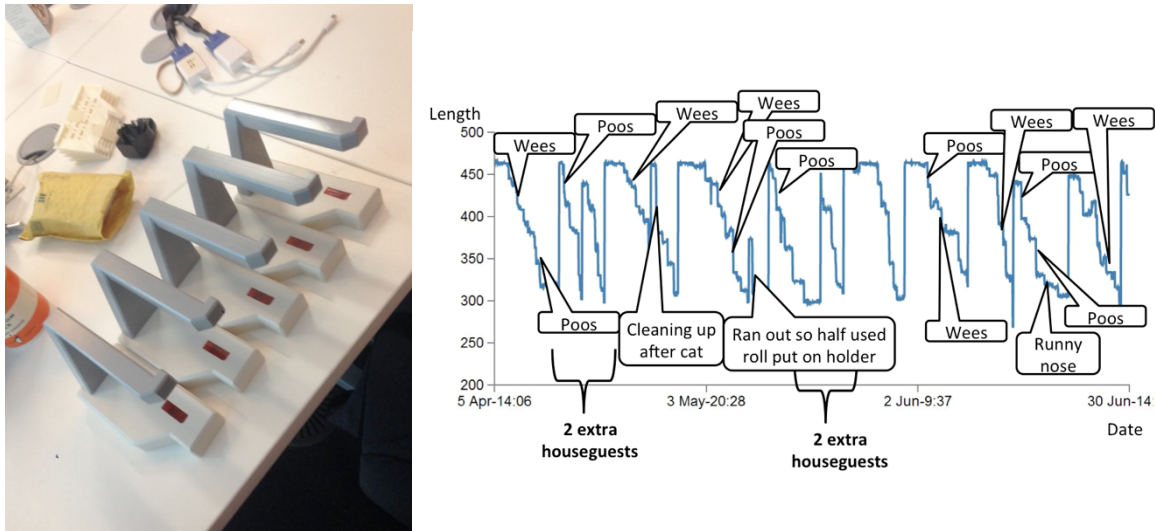


Figure 2 Five internet connected toilet roll holders waiting for deployment, and a screen capture of data streamed to the internet annotated with reflections from one owner.

An example of how the authors are involved in designing with data arises in the deployment of five internet connected toilet roll holders that fed back data to their owners. The design of the flow of data was relatively simple: each device concurrently measured the mass (and hence length) of remaining toilet paper, and streamed the values to a designated recipient.

The design solution was developed for an Internet of Things research project that provides a platform for owners of connected devices to lay claim to the data that they produce and begin to explore ways in which to trade with it. Current business models for IoT devices involve the customer purchasing a device that supports particular network functions, but often streams data back to the manufacturer who may sell the data to third parties, or use it to inform their own economic strategies. The Hub of All Things project (www.hubofallthings.com) seeks to provide a platform for people to manage the use of their own data and in turn identify value from it by either choosing to protect it, share it or potentially sell it.

Originally identified by the research team as a relatively easy Internet of Things device to design (compared to fridges and other domestic appliances), the toilet roll is at the centre of highly personal practices that take place behind locked doors and exemplifies the type of personal data that people may want to manage. Through the graph that is fed to a personal data store and visible in a browser, it is possible to clearly identify events that use significant amounts of toilet paper from which it is further possible to infer particular toilet activities; see Fig. 2. Upon further analysis, the graph also revealed a series of less likely events including cleaning up after cats, the running out of toilet paper, extra house guests, and somebody having a runny nose. The performative nature of the data emerges as families

begin to interpret the data to infer domestic practices, and in one case identify the presence of a stranger in the house, whilst a family were away on holiday.

Designing with data acknowledges that data is not a cold resource to be taken back to the lab or studio for examination, but a condition in which designers should anticipate the disruptive potential that is produced from streams of live data from networked artefacts. Trust, privacy, identity and security are concepts that as humans, we determine the value of within complex social and material practices. In order for designers to understand the breaches and disruptions involved in the human data interactions between internet connected things, we will need to develop 'design with data' methods in order to understand the value constellations that are produced and co-produced to support better management.

4.3 Design by data

Design **by** data: when systems are designed by other systems, largely autonomously, where new products and services can be synthesised via the data-intensive analysis of existing combinations of humans, computers, things, and contexts.

The final area is in the emerging prospect that data itself, supported by an algorithm, will become a designer. Such a circumstance is not so far away, according to Gartner, who predict: "By 2017, a significant disruptive digital business will be launched that was conceived by a computer algorithm." (Gartner 2014)

The scale of data that is being produced and co-produced through machine to machine and machine to human / human to machine interactions has proven to be exponential. It has been observed that approximately 90% of all of the data in the world has been produced in the past 2 years (Arthur 2013); whether this is in fact true now, the exact proportion is perhaps irrelevant. As the flow of data moves from web based applications, through mobile devices to networked objects, the data that is produced becomes the primary asset with which to sustain the value of products and services. If the information that is derived from the data and returned to the user does not demonstrate good value, then the user may drop the product. In order to identify valuable information, machine learning is being used across a wide variety of databases to identify patterns in order to elicit new insights (Bandyopadhyay & Sen 2011). Design by data suggests that as these algorithms become faster and better at identifying new opportunities to sustain or add value to products and services, it won't be long before data-driven objects begin to become designers within our lives.



```
"id": "2636", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:04", "is_active": "1"  
"id": "2637", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:05", "is_active": "1"  
"id": "2638", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:05", "is_active": "1"  
"id": "2639", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:06", "is_active": "1"  
"id": "2640", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:06", "is_active": "1"  
"id": "2641", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:07", "is_active": "1"  
"id": "2642", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:07", "is_active": "1"  
"id": "2643", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:08", "is_active": "1"  
"id": "2644", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:08", "is_active": "1"  
"id": "2645", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:09", "is_active": "1"  
"id": "2646", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:09", "is_active": "1"  
"id": "2647", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:10", "is_active": "1"  
"id": "2648", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:10", "is_active": "1"  
"id": "2649", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:11", "is_active": "1"  
"id": "2650", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:11", "is_active": "1"  
"id": "2651", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:12", "is_active": "1"  
"id": "2652", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:12", "is_active": "1"  
"id": "2653", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:13", "is_active": "1"  
"id": "2654", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:13", "is_active": "1"  
"id": "2655", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:14", "is_active": "1"  
"id": "2656", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:14", "is_active": "1"  
"id": "2657", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:15", "is_active": "1"  
"id": "2658", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:15", "is_active": "1"  
"id": "2659", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:16", "is_active": "1"  
"id": "2660", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:16", "is_active": "1"  
"id": "2661", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:17", "is_active": "1"  
"id": "2662", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:17", "is_active": "1"  
"id": "2663", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:18", "is_active": "1"  
"id": "2664", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:18", "is_active": "1"  
"id": "2665", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:19", "is_active": "1"  
"id": "2666", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:19", "is_active": "1"  
"id": "2667", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:20", "is_active": "1"  
"id": "2668", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:20", "is_active": "1"  
"id": "2669", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:21", "is_active": "1"  
"id": "2670", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:21", "is_active": "1"  
"id": "2671", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:22", "is_active": "1"  
"id": "2672", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:22", "is_active": "1"  
"id": "2673", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:23", "is_active": "1"  
"id": "2674", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:23", "is_active": "1"  
"id": "2675", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:24", "is_active": "1"  
"id": "2676", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:24", "is_active": "1"  
"id": "2677", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:25", "is_active": "1"  
"id": "2678", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:25", "is_active": "1"  
"id": "2679", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:26", "is_active": "1"  
"id": "2680", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:26", "is_active": "1"  
"id": "2681", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:27", "is_active": "1"  
"id": "2682", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:28", "is_active": "1"  
"id": "2683", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:28", "is_active": "1"  
"id": "2684", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:29", "is_active": "1"  
"id": "2685", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:29", "is_active": "1"  
"id": "2686", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:30", "is_active": "1"  
"id": "2687", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:30", "is_active": "1"  
"id": "2688", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:31", "is_active": "1"  
"id": "2689", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:31", "is_active": "1"  
"id": "2690", "device_mac": "8c2a6980448b", "the_time": "2014-09-27 14:15:32", "is_active": "1"
```

Figure 3 The ThingTank project adopts a design by data approach. Cameras attached to domestic objects allowed human researchers to identify activities, whilst data from internet connected devices allowed machines to learn about human activity. This combination enabled the researchers to identify more than human activities that were done while waiting for the water to boil (from a kettle’s perspective).

The case study that the authors have contributed to that best exemplifies a scenario of ‘design by data’ is the ThingTank project. The project was funded to explore the potential for identifying novel patterns of use within data that is streamed through the interaction between people and things, and things and things. Through an understanding of what data can tell us about how we use objects in practice, the project posited that new models of use would emerge and reinvigorate the role of things and people within design and manufacturing. In the past, many Internet of Things projects have used the network connection of artefacts to identify cost saving and process efficiencies (e.g., vehicle manufacturers), or to track goods within large networks (e.g., logistics companies), or to monitor the health and safety of systems (e.g., aircraft manufacturers). Such projects look for regular patterns within datasets which suggest efficiencies that will reinforce the identity of a product or service by making its function easier to use or more economical. By contrast, the ThingTank project proposed that looking for anomalies and outliers in datasets could suggest more radical design opportunities. During studies, the research team developed non-anthropocentric methods by gathering and streaming data from both material objects and humans that were involved in a domestic relationship, to better understand how machines could identify practices that went unidentified by human researchers (Giaccardi et al 2016).

Although the majority of us use products as intended, many of us also invent novel usages of objects by adapting or using them for unintended purposes. By scanning large datasets for evidence of mis-use and then using them to build new assemblages, the ThingTank project

proposes that algorithms may exploit data to design things that human designers could have never have conceived.

5. Reflections and Implications

Collectively, we term these three classes of designing from, with and by data as the “Ablative Framework” for design informatics, referencing the ablative grammatical case in Latin, which is used to cover “by, with or from”. The flow of data, and the generation of differing forms of value, are the central concerns and allow designers to reconfigure existing practices and methods to better understand the increasing performativity of data. The framework sees design **from** data as established methods for designers, and design **by** data as still highly emergent; whilst design **with** data is the important space of enquiry that requires urgent research to address the full extent of Human Data Interactions.

The Framework aims to offer a means of organising both existing methods but also of anticipating emerging methods that recognise the increasing performative qualities of data. The Framework is placed within a network society in which designers are working alongside a wide range of disciplines to mediate value within a constellation of stakeholders including algorithms. The Framework identifies different relationships between designers and data, and helps us see when the use of established ethnographic and designerly methods for gathering data **from** is required, or when the sustained flows of data require a design **with** data. The ThingTank example in fact demonstrates this neatly: the designers pursued traditional design methods, and then constructed flows of data from devices embedded in users’ practices and values, and then engaged machine learning to identify outliers, which points towards the increasing automation of new product design. So the project involved all three relations between design and data; the Framework does not instantiate a hierarchy for the three relations, and acknowledges the importance and interaction of all three within design research.

Uses of the three cases can be understood in terms of the need for some design projects that depart from the standard double diamond of design, with its pipeline of four stages: discover, define, develop and deliver. Such an approach typically identifies the behaviours and conventions that have to be observed, and finds ways of sustaining them. With the advent of designing alongside data, there is limited chance to freeze the discover and define stages, because data will continue to be received from users and communities that adjust the value proposition of the product or service that has been delivered.

Design is adjusting from providing services that add value along the traditional value chain, towards playing an active role in the mediation of value within a constellation in which data provides feedback, or even takes control. Frameworks such as the one proposed here provide tools which help us understand which methods to adopt, and when. Some of those tools should be very simple, taking the form of checklists for practitioners that respond to the following questions:

1. In contexts in which humans, computers and artefacts are in close interaction, how can designers identify measurable features from which data can be elicited to better understand the values in play, and how can they design interventions to capture data in a manner that is sensitive to human values?
2. In contexts in which data is flowing in such a way that it is performative, informing and affecting the behavior of humans and artefacts, how can the design team develop systems that capture the existing flows, and offer interventions that support and enhance human values?
3. In contexts in which systems are designed by other systems, how can designers mediate the development of products and services that are synthesised by data processes, to ensure that the values of the systems are commensurate with the values of the human and more than human participants?

In future work, we aim to exercise these principles and make them broadly available for design research.

1. **Acknowledgements:** Design research for this paper originated from the following grants: The Internet of Secondhand Things project funded by an EPSRC grant (EP/K012819/1) and Oxfam UK; The Hub of All Things project funded by an EPSRC grant (EP/K039911/1); and the ThingTank project funded by the Skoltech Foundation, Russia. Thanks go to the many participants who supported the research, and we are grateful to our reviewers for their constructive suggestions for improving the paper.

5. References

- Austin, J. L. (1962) *How to Do Things with Words*. Oxford: Clarendon Press.
- Bandyopadhyay, D. & Sen, J. (2011) *Internet of Things: Applications and Challenges in Technology and Standardization*, *Wireless Personal Communications: An International Journal archive*, 58(1), 49-69.
- Bernard, R. (2000). *Social Research Methods: Qualitative and Quantitative Approaches*. Thousand Oaks, CA: Sage publications.
- Cox, G. (2013) *Speaking Code: Coding as Aesthetic and Political Expression*. MIT Press, Cambridge, MA.
- Dewsbury, J. (2000) *Performativity and the Event: Enacting a Philosophy of Difference*. *Environment and Planning D: Society and Space* August 2000 18: 473-496,
- Norman, D. (2006) *Why doing user observations first is wrong*. *Interactions* 13, 4 (July 2006), 50-ff.
- Hemmings, T., Clarke, K., Crabtree, A., Rodden, T. and Rouncefield, M. (2002) *Probing the probes*, *Proceedings of the 2002 Participatory Design Conference*, pp. 42-50, Computer Professionals for Social Responsibility.
- Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H., Roussel, N and Eiderbäck, B. (2003) *Technology probes: inspiring design for and with families*. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*. ACM, New York, NY, USA, 17-24.

- Hine, C. (2000) *Virtual Ethnography*. London: Sage.
- Gartner (2014) *Gartner Reveals Top Predictions for IT Organizations and Users for 2015 and Beyond*. Garner. Weblink: <http://www.gartner.com/newsroom/id/2866617> Accessed 10th November 2015.
- Giaccardi, E., Speed, C., Caldwell, M. & Cila, N. (2016) When Objects Become Co-ethnographers: Potentials of a Thing-Centred Approach in Design and Anthropology, in (Eds) Binder, T., Kjærsgaard, M. & Charlotte Smith, R. *Design Anthropological Futures*, Bloomsbury.
- Kawulich, B, B. (2005) *Participant Observation as a Data Collection Method*. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, [S.l.], v. 6, n. 2, May.
- Keeley-Browne, E. (2011). Cyber-Ethnography: The Emerging Research Approach for 21st Century Research Investigation. In G. Kurubacak, & T. Yuzer (Eds.) *Handbook of Research on Transformative Online Education and Liberation: Models for Social Equality* (pp. 330-238). Hershey, PA: Information Science Reference. doi:10.4018/978-1-60960-046-4.ch017
- Kozinets, Robert V. (2006), Netnography 2.0, in *Handbook of Qualitative Research Methods in Marketing*, ed. Belk, R.W. Cheltenham, UN and Northampton, MA: Edward Elgar Publishing, 129-142.
- leCompte, M. & Schensul, J. (1999). *Essential Ethnographic Methods (vol. 2): Ethnographers Toolkit*. New York, NY: Altamira press.
- Miller, D., and Slater, D. (2000). *The Internet: An ethnographic approach*. Oxford; New York: Berg.
- Mortier, R., Haddadi, H., Henderson, T., McAuley, D. & Crowcroft, J. (2014) *Human-Data Interaction: The Human Face of the Data-Driven Society*. Available at SSRN: <http://ssrn.com/abstract=2508051> or <http://dx.doi.org/10.2139/ssrn.2508051>
- Normann, R. & Ramirez, R. (1994) *Designing Interactive Strategy: From Value Chain to Value Constellation*. John Wiley & Sons.
- Speed, C., Hartswood, M., Laurier, E., Magee, S., de Jode, M. & Hudson-Smith, A. (2014) The Huggle-O-Tron: design intervention in secondhand retail. *Proceedings of the 2014 companion publication on Designing interactive systems*. Pages 137-140. ACM New York, NY, USA. ISBN: 978-1-4503-2903-3 doi:10.1145/2598784.2602802
- Speed, C. & Maxwell, D. (2015) Designing through value constellations. *interactions* 22, 5 (August 2015), 38-43. DOI=<http://dx.doi.org/10.1145/2807293>
- Wilson, S. M., & Peterson, L. C. (2002). *The Anthropology of Online Communities*. Annual Review of Anthropology 31: 449–467.

About the Authors:

Chris Speed is Professor of Design Informatics within Edinburgh College of Art, University of Edinburgh. Chris is Co-Director of the Design Informatics Research Centre that is home to researchers working across interaction design, temporal design, anthropology, software engineering and cryptocurrencies.

Jon Oberlander is Professor of Epistemics within the School of Informatics, University of Edinburgh. He works on getting computers

to talk like individual people, so he studies how people express themselves and develops systems that can adapt themselves to people.