# Understanding the needs and desires of service users in the design and creation of meaningful physical data representations.

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**Abstract**

This paper draws on the experiences of a small team of researchers, led by Professor Gwilt, who have been exploring novel ways of translating data into physical formats through an investigation into the potential for data-driven objects to help in the communication and sharing of data. The paper draws on a selection of research projects undertaken within the context of healthcare and wellbeing wherein data-objects were designed to help a variety of service users engage with data.  A number of different data-object making and development strategies are discussed, and considered in terms of their effectiveness as communication tools. This discussion includes reflections on; finding and creating data sources, engaging with service users, thinking about the use of visual language, metaphor and material choices, audience needs and experiences, contexts of use and deployment.
Observations on the conceptual process of creating hybrid objects and the social-cultural value systems employed in reading these artefacts are also debated. A list of guiding principles for the creation of meaningful physical data representations has been developed by the authors and is presented in the

context of the epistemology of the data-object and how we might implement these methods to ask questions around the pedagogy of the Physicalisation of data.

## Author Keywords
Data-objects, co-design, information design, information visualisation, physical data

## Introduction
Data is the new digital currency; understanding what different forms data comes in, how it is created and by whom, where it can be accessed and how it is being used are increasingly important questions for a society that has embraced digital technology.  Without question the generation, collection, analysis and use of digital data is having a dramatic impact on social, economic and political cultures and services (Prendiville, Gwilt, & Mitchell, 2017; Mayer- Schönberger & Cukier, 2013). As citizens we are actively engaged in producing and consuming data, from the monitoring of personal health statistics, to the data collected by our various service providers (both sanctioned and by default), and through the public records that comment on the state of the nation.

As digital data has become more accessible, designers and computer scientists have taken to the task of visually interpreting data with gusto and a huge range of data presentation forms from statistical lists to visual representation techniques such as; bar charts, graphs, diagrams, illustrations, 3D models, maps, animations, and generative designs already exist (Kirk 2016). It is in this context that we will consider the use of physical objects as carriers of data and ask the questions:

• Can the creation of physical objects based on data extracted from digital information systems change the way we read, interpret and respond to complex information?

• And by reconceptualising digital information into a physical object can we add new insight to information to people outside of a scientific or specialist community?

## Finding and using data sources
There is an assumption that the new paradigm of open data creates an automatic level of transparency in how data can be accessed and used. Prior research by the authors has shown that many people find it difficult to understand and/or relate to statistical lists and graphs (Gwilt, Yoxall, & Sano, 2012). As Kennedy suggests (2015), we relate to data both cognitively and emotionally and this embodied technological experience forms an important backdrop to current thinking around the Internet of Things (IOT), smart environments and objects.

In a recent research exercise the authors embarked on the process of finding, interpreting and using a publically accessible, open data set from the UK healthcare sector.  This process revealed a number of problems around how easy it is to identify and use an open data source. Further issues were encountered around where to locate datasets, what form these datasets are stored in, how to read and open file formats, as well as concerns around data legitimacy and relevance. These issues are often overlooked when talking about the public use of data and the process of working with data, and would be a good topic to explore within the workshop.
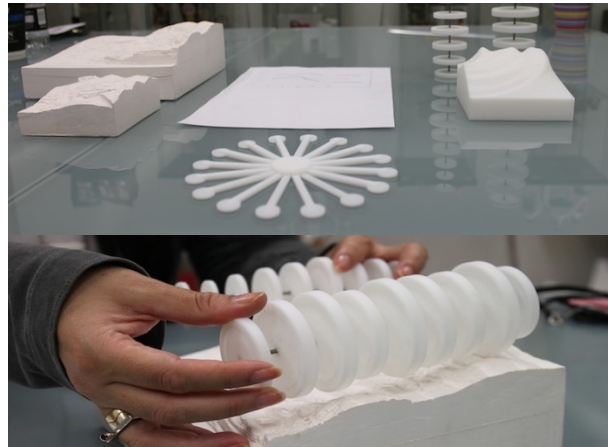
**Figure 1**: Data-objects. Testing a range of data visualisation forms. In user-testing exercises data gathered on the strength and dexterity required to open domestic packaging was presented to users to explore what forms and materials might aid cognition and engagement.  (I. Gwilt, A. Yoxall, K. Sano & N. Dulake 2012)

## Engaging with service users

Choices in how to visualize data as a physical object should be driven by user needs and expectations and context of use. Therefore, it is important to engage user communities in as much of the data visualisation process as possible.  This ranges from including users in decisions on what data to work with, what are key things to communicate from the data, to thinking about the use of different forms and visual metaphors through which to interpret and realise the data. A good understanding of the needs and requirements of the intended audience, and when and how the data is to be examined is a must. A conversation around strategies for co-creation could also be discussed in the workshop; how can we accommodate user needs and

knowledge, thinking around context of use, and complex and specific audiences.
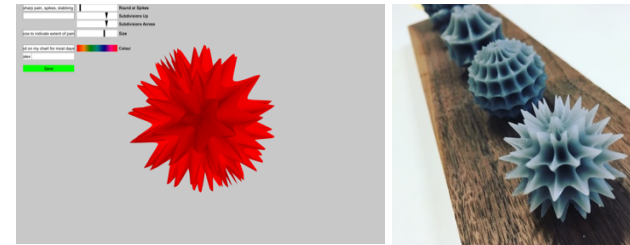


**Figure 2:** Data-objects used to describe individual pain profiles created by young adults suffering with chronic-pain.  Pain parametrics are manipulated through a software interface that allows an individual's bespoke pain model to be visualized. These are then produced using a 3d printing process. (N. Dulake & I. Gwilt 2017)

## Value systems and reading physical data

By translating data into a physical object we bring into play attributes, properties and values, which are typically assigned separately to digital and material cultures.  The use of visual metaphor, fabrication process and material choices have all been seen to influence people's perception of the underlying data - there is a relationship established between the physical affordances of the object, such as shape, texture, scale and weight, and the interpretation of the data that object represents. For example, the amount of granularity or texture of a surface would appear to correlate with the perception of how much data that surface represents, e.g. textured surfaces suggest more data, smooth surfaces less and so forth. As Sennett observed (2009), the qualities of material cultures are extremely important when establishing and assigning value to the things we use. The data-object uses a combination of both digital and material

elements to foster insights and comprehension to complex data.



**Figure 3:** The dataseeds project uses the metaphor of the sycamore seed to represent NHS open data statistics on 'falls on and from stairs and steps'. Instances of the data are physically represented in the form of sycamore seeds that fall and spin at different rates to visually and dynamically interpret the data - the data informs the surface areas of the wing which dictates the spin and falling speed of the data-object. (N. Dulake & I. Gwilt 2015)

### Guiding principles for creating a data-object

Each data-object should be designed with a specific data-set and audience in mind. Some of the approaches that might be undertaken in the creation of a physical data-object have been discussed above. The authors have drawn up a sequence of guiding principles that should be considered before creating a data-object:

• Consider what the creation/use of a data-object will contribute to the communication of the underlying data and to whom

• Consider your audience and what their expectations from the data might be

• Carefully select the data set, paying attention to the credibility of the data source

• Carefully examine the chosen data set to identify the significant key message/ messages in the data

• Consider how design choices of form and/or use of visual metaphor relate to the underlying data

• Where possible involve your user community in all stages of the design and decision making

• Make sure the data object's form and physical qualities remain faithful to the underlying data

• Consider how the use of any fabrication techniques and choices in material might amplify or sympathetically reflect key trends in the data

• Consider where and how the data-object might be encountered and in what context

• Consider how the data-object might work with other forms and fit into a larger communication strategy

To conclude, it is important to stress that the authors do not envisage that the data-object is a way of substituting other forms for communicating data. The data-object should be seen as a technique that when given the appropriate consideration has the potential to add to the understanding and cognition of any given dataset. Equally the authors suggest that making data publically available is only the first step in thinking about how digital data can be accessed and shared in meaningful ways by a range of different audiences.

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