DataBronze

The influence of material choices on the understanding of information represented as a physical object.

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Abstract: This paper reports on a set of ongoing research activities that explore how the representation of complex statistical information can be communicated through the construction of physical, 3 dimensional objects. Working with engineers to supply the initial data, and creative practitioners to design the objects, traditional and digitally based techniques have been employed to make objects that can be used as tools to help aid cognition and understanding of complex information systems, for non-scientific or non-specialist audiences. In particular this paper sets out to examine what the implications of using bronze as a making material has on the representation and understanding of information embedded in the data-object.

The paper begins with a brief introduction to the concept of the data-object. This is followed by an outline of the fabrication process undertaken in the creation of an exemplar object through to the casting of a bronze artifact. An investigation into the social/cultural attributes, value systems and attendant qualities associated with the use of bronze in sculptural artifacts is then discussed. Next, we describe a simple user-based study, conducted to compare the influence that different material properties (bronze and plastic, using traditional and digital fabrication techniques) might have on the perceptual and cognitive understanding of information presented in a 3 dimensional, physical object. Finally, some conclusions are drawn from the research to date.

Key words: information visualization, tangible data, material cultures, digital materiality

1. Introduction: what do we mean by a data-object?

As computer-based processes, work practices, networks, systems, social and communication media, signal an increasingly technologically enabled and dependent society, the relationship between digital and material paradigms, and our expectation and understanding of the differences and commonalities for objects and artifacts traditionally located in one or other of these paradigms, is becoming increasingly connected and interrelated.

Until recently the primary engagement and experience of digital technologies for most people was centered around the desktop computer. The desktop computer operated with all the attendant ergonomic qualities and value systems of a physical artifact and tool, but also provided a screen-based human computer interface through which we could access the digital world [1]. Other early touch-points with the digital were played out through the uptake of digital broadband media, (audio and televisual) and public interfaces such as cash-point machines and credit card payment systems.

However, more recently the rise in touch-screen technologies, smart-phones, ‘location-based media’ and the ongoing development of a variety of portable devices, user interfaces and visual languages speak to the diffusion of this gateway, wherein we begin to see our interaction with digital technology becoming a pervasive and ubiquitous set of activities in the everyday. Aided by increasing participation in social and networked media, and the popularity for terms and ideas such as ‘The Internet of Things’, ‘smart environments’ and ‘Augmented Reality’, the digital is becoming increasingly woven into the fabric of material cultures and our lived occupation of Cartesian space.

With this in mind, the data-object concept is based on exploring how we might begin to utilize, if not simply manage, the inherit traits and properties which we typically and traditionally ascribe to each of these environments (the digital and the material). From the digital we might expect to inherit conventions such as networkability, morphology, replicability, complexity and so on. From material culture we might pick up on notions of value, heritage, longevity, authority etc. [2].

This notion of the data-object as a combination of both digital and material elements allows us to begin to investigate how attributes and properties that are typically assigned separately to digital and material cultures might begin to work together, while retaining echoes and reference points to their digital/material origins and characteristics. Philosophically the process of turning digital information into a physical (analogue) object might appear to be at first sight illogical, as by fixing digital data in time and physical space we appear to disable much of the dynamic potential in the digital. However, this research attempts to understand if data-objects have the potential to capitalize on the inherit traits found in both digital and material cultures and moreover, if these hybrid constructs offer a new way of looking at the digital/material relationship. In particular the research is interested in finding out if the fusion of properties from both paradigms can foster insights and comprehension to complex data, which might be difficult to understand in other more traditional forms such as statistical lists and graphical representations like graphs and tables.

2. Data selection and initial research

To explore the concept of the data-object we focused the research on the interpretation of scientific data sets collected by Dr Alaster Yoxall and his team from the Engineered Packaging Research Group at the University of Sheffield, which explored the relationship between 'age and dexterity/strength’ [3]. This data was centered around the difficulties experienced in opening consumer packaging, which has been identified as a major issue as we move towards an increasing older community. A number of grip test trials were undertaken based on a variety of containers with different size lids and opening styles. The findings of the trials suggested that the problem of reduced dexterity and strength meant that packaging designed for use by a younger, fitter or healthier person could become difficult or impossible to access for an older person, an issue that potentially has both physiological and esteem issues.

The scientific data was collected using a variety of research methods and recorded in a number of forms including numeric data, collected from the grip test experiments, interview transcripts and video recordings. For the purposes of the data-object study we were interested in how we might begin to interpret the ‘raw‘, numeric data gathered from the grip test trials. This involved two distinct stages; first, the creation of data-objects developed from a selected data set and second, usability testing of the data-objects with participant groups.

After it was decided which specific data set was to be used for the data-object study a series of design activities were undertaken as a method for considering how the information might be visually and physically interpreted. Working alongside the engineers who undertook the original research, creative professionals (both artists and designers) devised a number of ways to re-imagine the data. This took the form of a number of visual metaphors, realized through sketches and drawn ideas, which in turn informed a series of developmental physical models. From these models we were able to produce prototype data-objects that could be used to present the research to a variety of audiences. From the initial ideas a small selection of visual metaphors that showed different ways of interpreting the data were chosen. Fabrication techniques using digital and traditional conventions were then explored. These included the use of digital 3d modeling software and rapid prototyping printing processes, as well as the creation of handcrafted clay and plaster-based objects. Preliminary testing of these initial data-objects was conducted and while a detailed description of the processes used in this early work has been documented elsewhere [4], the following section discuss the importance of material choice to the data-object concept, an issue which came out of this early research and which forms the basis of the study described in this paper.

3. Materiality

In this section we will begin to consider how choices made around use of materials and the associated fabrication processes might impact on the cognition and perception of data represented within their form.

Beyond structural and physical characteristics the importance of material selection by designers to communicate ideas and give character to a product has been investigated by Karana, Hekkert and Kandachar [5]. The authors identified how intangible properties such as emotions; meanings, associations, and cultural differences are communicated through material choice.

In a new study we compare two different data-objects; one made from bronze, and one made from FDRP (Fuse Deposition Rapid Prototyping) plastic. This comparison allowed us to begin to explore what affect these material choices might have on the comprehension and cognition of the data that drives the shape of the objects. We were also interested in the making/fabrication process required to create each object and whether or not these processes (digital and analogue) have any influence on the perception of the data encapsulated within. Both the bronze and plastic versions of the data-object used the same information and visual metaphor to visualize their form, and both were made to the same size and proportions.

It could be argued that the use of bronze brings with it notions of history, power and authority, as Ekserdjian states “Bronze, like no other artistic material, has been used all over the world…to make works of art and artifacts of extraordinary beauty. Highly prized and durable, it is an age-old medium associated with great historical epochs.” [6]. The lost-wax casting technique (used here) is an ancient technology dating back to over 5000 years ago, with the earliest technical account of the process described by the medieval metalworker Theophilus in a 12th century manuscript [7].

Conversely the FDRP technique is a contemporary making processes facilitated by digital technologies that allows for a cost effective, low volume production of plastic models, but results in a model with rough surface resolution (in comparison to the bronze data-object) and is light in weight. We were also interested in ascertaining if the environmental issue of the negative image of plastics, how plastics have symbolized cheapness, low quality

and in-authenticity, and how difficult it is to change these attributes for new forms of plastic would impact on the perception of the data within the object [8].

As we will see in the following section, notions of materiality and immateriality are strongly realized in the fabrication process of the bronze object. The freedom of immaterial information, which is often ascribed to the digital, is very much grounded through the making processes of the bronze data-object. Benjamin's cultural ideas around the value or 'aura' of the original and issues of mechanical or in this case digital reproduction are also played out through the concept of the data-object [9]. The bronze data-object throws into relief the different value systems, which separately accompany digital information and physical objects.

4. Making a bronze data-object…

Subsequent to initial trials in data-object making a further data-object was produced using a traditional bronze casting method. This object, which we refer to here as the *databronze* (2013), was based on the landscape metaphor developed in the first testing stage outlined in section 2. In the landscape metaphor the parameters of the terrain are driven by statistical findings on the relationship between strength/dexterity and age, for both males and females. The higher ground represents increased strength, which tends to decrease with age and is represented in the lowering of the terrain. Temporal progression is represented along the sides of the model. It is the combination of these two factors (time/age and strength) that informs a particular topology, which is driven by the data (See Figure.1). The landscape across the surface of the object was interpreted by the artist (an approach that will discussed in the later section), and the smooth section on the top face of the work represents the 'critical' point at which it becomes impossible to complete the original grip test.

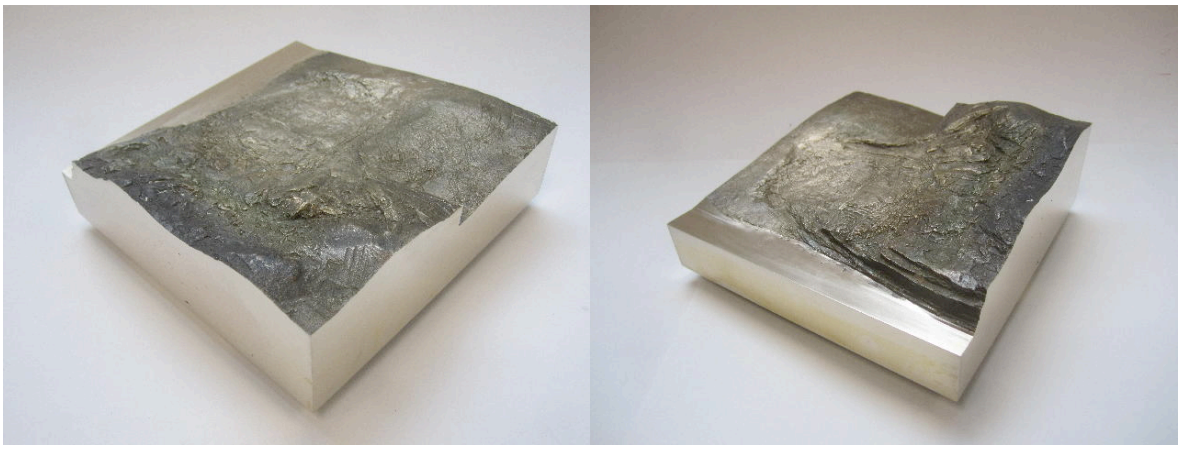

Figure.1 Images of the finished *databronze (2013).*

This work was undertaken primarily by Dr Koutaro Sano, a Japanese academic, ceramicist and maker, during a visit to Sheffield Hallam University in 2012/13. The work was made possible with the help and support of Dr Cóilín O'Dubhghaill a Senior Research Fellow in Metalwork and Jewellery, and with the extensive technical support and facilities provide by the School of Design workshop and staff. The Databronze was first modeled in clay, from which a plaster mould was produced, and subsequently a wax copy was produced from this mould. Wax sprues, risers, and pouring cup (the passages through which the molten metal will flow) were added to the

wax, and the wax was surrounded by a refractory (high temperature) plaster mould. This casting mould was then heated and de-waxed to produce a hollow space into which the molten bronze was poured. After the bronze had cooled and solidified, the Databronze piece was removed from the plaster investment. The edges of the piece were milled to produce a smooth surface, defects were repaired by welding, and the piece was then hand-polished to produce a quality surface finish. Finally, the sides of the Databronze were photo-etched with symbols relating to the age and gender data. In Figure. 2 an edited photo-essay of the processes involved in fabricating a cast bronze object are shown.

While it is recognized that the fabrication of a 3D digitally printed object is in its own way a complex and time consuming process (which should not be underestimated), for the purposes of this research we have concentrated on the making process required in the production of a bronze cast data-object. Contemporary Rapid Prototyping making processes and techniques are documented in a number of publications and online forums, see the publication *Rapid Prototyping Principles and Applications* as an example [10]. Comparing and contrasting the technical expertise, equipment, time frames, finishing and preparation processes between a digitally enabled 3d printed plastic data-object and a cast bronze data-object is for a further study.

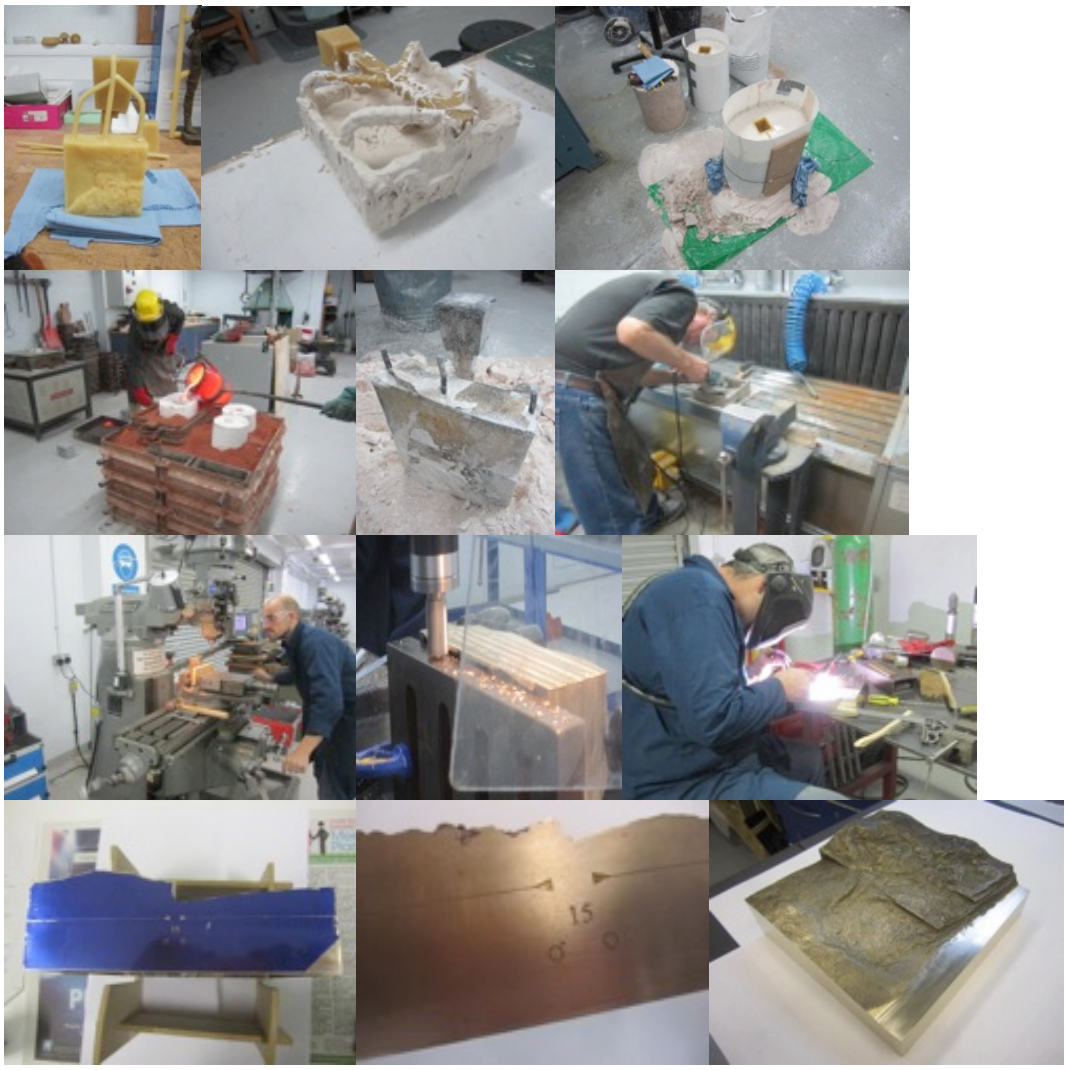

Figure.2 Processes involved in fabricating the cast bronze data-object

5. Audience responses to the bronze and plastic data-objects

Within this study we will test in particular two aspects of the data-object concept. First, to further examine if the data-object, through a combination of both digital and material characteristics, might be used to help communicate complex statistical information in a new and engaging way, and second, to test the impact of material choice on the perception/comprehension of information presented in the form for a data-object. For this purpose two versions of the same data-object, one in plastic, made using a digital 3d printing fabrication process, and one in bronze, made using the traditional bronze casting process, were produced. Using a process of semi-structured interviews and empiric interaction with the objects, a number of people (30 adults, male and female between the ages of 25 – 55) will be canvassed in respect to their understanding of the data-object concept as experienced through the 2 data-object examples presented. During individual 15 - 20 minutes session a series of contextual and directed questions will be used to discuss the general concept of the data-object and make particular reference to the individual material choices of the 2 data-objects and their impact on the nature, quality and meaning of the data encapsulated within the objects. Responses from the participants will be documented through a note-taking and photographic process and all participant contributions will be anomalized.

NOTE: Please note that these interviews are scheduled to take place in April 2013 and it is intended that the findings from this process will be presented at the IASDR conference in Tokyo in September 2013 and that this paper will be updated with the findings for the final submission on 28 June 2013.

6. Conclusions

As part of a larger investigation into the concept of the data-object as an example of the ongoing confluence of digital and material cultures outlined at the start of this paper, it is possible to propose that at the very least the data-driven physical artifact can act as a provocation or a vehicle to initiate conversation around the meaning and intention of the encapsulated data. In his text on Post-Optimal Objects, Anthony Dunne discusses the unstable nature in the relationship between digital 'electronic' artifacts and physical objects, a premise that is expressed in the idea that the data-object as a confluence between material and digital cultures where differences in these cultures can be challenged or explored [11]. User testing of the data-objects also attests to the fact that these forms are dialogic in nature and can act as a trigger for a discussion around meaning and intention, Indeed, 'critical artifacts' (not necessarily driven by data) have previously been used as a vehicle for designers to communicate and prompt reflection by audiences and end users [12].

Moving beyond the 'optimal' qualities espoused in traditional data visualization choices (such as statistical lists and graphs) within the concept of the data-object a contested space can be created, as was the case through the addition of an artistic interpretation of the data in aspects of the bronze landscape discussed above. In this space 'between data' speculation and conjecture can occur, where meaning can be found not imposed. John Dewy reflects on the poetics of experience and the "expressive object" wherein meaning can work on a number of levels – in this respect the data-objects operate both as a cipher for the encapsulated data contained with them, but also has meaning as an experienced object [13]. Furthermore, if digital culture is perceived to be dynamic and in constant flux, then the crafted object, according to Sennett allows us "…to return to them again and again… and linger" [14]. This notion of longevity is certainly a feature of the bronze object, which has the potential to physically remain stable over generations. But what then does this longevity mean for any information that may

be contained within such an object? Moreover, this permanence does not come without considerable effort, as we have seen in the documented making process of the *databronze* object above. In relation to the use of bronze as a material there are obvious and well-established cultural associations that accompany its use, however Luc Pauwels begins his book on the visual cultures of science with the statement that "The issue of representation touches upon the very essence of all scientific activity. What is known and passed on as science is the result of a series of representational practices." He goes on to say that, "Visual representations are not to be considered mere add-ons…they are an essential part of scientific discourse." [15]. These statements point to the fact that careful consideration as to how we can begin to visualize science, and what form these visualizations should take is clearly required.

As we shift away from the notion of an existent binary opposition between digital and material cultures towards more integrated digital/analogue constructs, opportunities for re-imagining complex digital data sets as physical objects that can inhabit our material spaces are beginning to take shape. This paper forms part of an exploration into how syncretic forms such as the *databronze* data-object might exploit qualities and attributes from digital/material cultures to aid cognition and offer new insights and understanding to complex digital data. Advocating the concept that, through the use of craft/making techniques; an understanding of material affordances, visual metaphor, new manufacturing processes and physical/digital properties, artists and designers can begin to examine how we might creatively combine attributes borrowed from both digital/material paradigms to reconfigure and re-visualize complex data and information sources into forms that resonate within different sectors of the community.

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