Digitally Fabricating *Data-Things:*

A Participatory Approach to Making Data Physical

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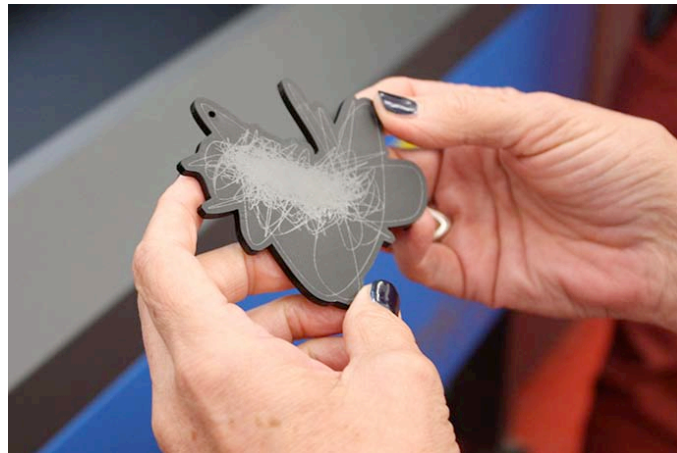
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Fig. 0: A *data-thing* generated from craft gestures

Abstract

In this position paper I'm discussing examples of design-led work translating data, generated by participants, into tangible, digitally fabricated artefacts to encourage reflection, discussion and conversation. The emphasis of this work is in the direct involvement of the participants in the process of 'data-making' and digital fabrication. I am showing that the value of 'Making Data Physical' does not only lie in the end-product of physical data representations, but also in the direct involvement of audiences in shared, participatory data translation activities using digital fabrication. Such a longer-term, active engagement of participants with relevant data encourages reflection, prompts discussion and supports meaning making processes.

Author Keywords

Research through design, digital fabrication, data materialisation, data souvenirs, participatory fabrication

Introduction

Although having been around for many years, physical data representations have recently seen a revival in HCI research due to developments in digital fabrication technologies and their potential for personalization. Some areas of explorations focus on the efficiency of data representations [3], supporting behavior change [4] and categorizing different aspects of physical data

1)Audience Experience Data

Fig. 1(a): Digital interface, generating new data from participants' feedback

Fig. 1(b): cutter plotter digitally fabricating the souvenirs

Fig. 1(c): Examples of personalized souvenirs

representations [10]. The use of data in the work I am showing here may be similar to what Vande Moere classes as *data sculpture* which ""embody" the data in a perceivable presence, shape or form" [10]. Often seen as fixed, 'objective' translations of data into physical artefacts for a more tangible engagement, I am suggesting a more subjective, personal interaction with data through making. By giving participants more ownership of how they translate data into personal data artefacts, I propose the artefacts take on different meaning.

This work is building on research that places digital fabrication at the core of situated engagement activities, in particular Ogawa et al. [8] kerning the term "Social Fabrication". More generally, digital fabrication is playing an important role in the expressiveness of the DIY maker community [9] with its rising culture of creating and sharing [5]. Increasingly drawing from such maker, craft and design communities, research acknowledges that participating in making creates a richer engagement as well as providing occasion for conversation and reflection. Ingold [2] for example distinguishes between the different ways we can relate to an artefact depending on our participation in its making, the extent to which we have an affective relationship to its constituent materials and whether we feel we partake in the 'lifecycle' of the artefact, or experience it as an alien object. The more an object is a standardized artefact of mass-production, presenting us with pre-fabricated meanings and generic associations, comprised of materials we have little sensuous engagement or emotional resonance with, the more it is alien. Extending this Heideggerian perspective of artefacts made this way taking on the character of 'things'

connected to their circumstances of making, rather than alien 'objects' created by mysterious processes, I conceive of the data artefacts made through participatory translation processes as 'data-things'.

To further elaborate on this position, I am discussing three examples of design-led projects exploring how through the process of making data physical, we can engage audiences with reflection, conversation and discussion. Their commonalities are (a) in embedding data within digitally fabricated tangible artefacts, (b) situating digital fabrication within unique participatory contexts, and (c) the relevance of the selected data to audiences and their context. In summary I will draw insights to further the discussion of data physicalisation not only being seen as 'representation of data' but as meaningful, personally created 'data-things'.

1 - Audience Experience as Data-Things

In this project I embedded digital fabrication into the trajectory of a souvenir making activity at an art exhibition to elicit feedback from the audience whilst encouraging participants to reflect on their experience [7]. The designed activity was then performed in three stages, firstly an interactive interface which allowed visitors to generate a personalized shape based on their feedback about the exhibition (Fig.1a). Secondly, these generated shapes were then fabricated using a cutter plotter in a transparent fashion to allow participants to partake in the fabrication process directly (Fig.1b). And lastly the personalized artefacts were kept by the participants as a souvenir of their visit and experience of the art exhibition (Fig.1c).

In this work, I used the experiential capacity of digital fabrication to not only materialize data as

2) Conference Tweet Data
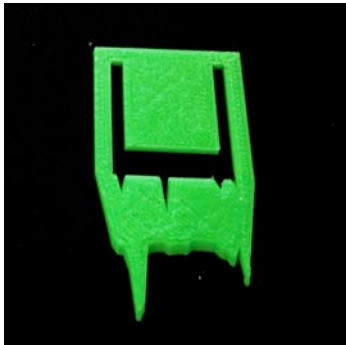

Fig. 2(a): Tweet Fabrication Activity

Fig. 2(b): A fabricated *data-thing*

Fig. 2(c): Comparing twitter activity via materialisations

representations but to elicit data from the audience while live fabricating their data into physical mementos. This participatory activity allowed visitors to reflect on the exhibition they had visited and allowed for a more personal meaning making process which was encapsulated in each personalized souvenir.

2 – Conference Tweets as Data-Things
During a conference I translated hashtagged tweets generated live from attendees of the conference into physical artefacts for conversation and dialogue [6]. I developed a 3D printable design (Fig.2b) that would materialize the amount of tweets relating to each attendee's username over the course of 24 hours during the conference (Fig.2a).

For this purpose, I used data implicitly generated by the participants to generate abstract, personalized shapes exploring their potential to open conversations amongst conference attendees and reflect on individual's twitter behavior. In some instances, the artefacts were being explored in shared use as comparisons and conversation starter (Fig. 2c).

3 – Crochet Movements as Data-Things
The third project is set in the context of craft practice – more specifically of crochet practitioners. Exploring how embodied movements of craft can be translated into material form this work engaged practitioners with their practice in new ways. Particularly, we tried to study the role such *data-things* can play in shared communication and reflection on craft practices and techniques [6].

In this study, we captured sensor data from the craft practitioners' tool, a crochet hook, during a specific craft activity (Fig.3a). Data was generated by the

participtants' embodied movements which was then used to develop a range of designs generating unique shapes for the participants to discuss as a group (Fig.3b). Conversations lead to practitioners discussing and reflecting on their practice and even their personalities. This study focused more on the comparison of the participants' involvement from not being to being part of the overall process of data capture, data translation and digital fabrication. One participant highlighted that the object "feels like it kind of has more meaning" [6] when participating in the whole process of making her *data-thing (Fig.3c)*.

Summary
I have outlined these design-led projects here in brief to show the differing ways data was generated, translated and digitally fabricated and the extent of which participants were involved in the making process. To summarise, I draw out five shared aspects that emerged from a comparison of project findings:

▪ *Participatory data generation* includes the audience in the generation process of relevant data, explicitly or implicitly, to increase personal investment.

▪ *Ambiguous data translations* support Gaver et al.'s [1] proposition that ambiguity has the potential to "encourage close personal engagement" through conversation and reflection.

▪ *Participatory digital fabrication* engages audiences with the process of data translation as experiential tool to elicit data, reflect upon behavior and encourage reflection.

▪ *Aspects of meaning making* extend beyond the experience of the physical data representation as

3) Crochet Movement Data

Fig.3(a): Generating crochet data

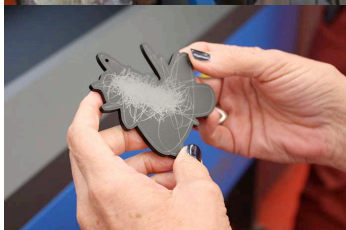Fig.3(b): Discussing the different shapes and designs

Fig.3(c): Participatory laser cutting and final data-thing

artefact to a more inclusive view of making *data-things* in shared, social and reflective activities

▪ ***Situating data in a trajectory of use*** encourages data being understood not as static but as malleable medium to be processed, translated, reduced, abstracted or interpreted in different, personal ways

Challenges and Further Thoughts
In each of these projects clear challenges and compromises arose for embedding digital fabrication in meaningful data making activities. Not only technical aspects such as fabrication speed, annotatability and transportability [7] played an important role in creating valuable and unique experiences for participants. The appropriateness of the technology for the context in which the activity was taking place is as important as considering the audiences' background, abilities and interests.

The speed of improving fabrication technologies will see technical restrictions minimised in the near future. On a more conceptual level, questions remain to be critically explored as to how data is manipulated and translated into physical form that is meaningful to its audiences. How can participants or audiences be more involved in the overall trajectory of meaning making with data? And what aspects of tangible, fabricated artefacts add value and meaning to users' experience and perception in comparison to purely digital data presentations?

Acknowledgements

References
[1] Gaver, W., Beaver, J. and Benford, S. Ambiguity as a Resource for Design. In Proc. *CHI'03.* ACM (2003), 233-240.

[2] Ingold, T. Making: Anthropolgy, Archaeology, Art and Architecture. Routledge, 2013.

[3] Jansen, Y. Dragicevic, P. and Fekete, J.-D. Evaluating the Efficiencey of Physical Visualisations. *In Proc. CHI'13*. ACM (2013). 2593-2602.

[4] Khot, R., Hjorth, L. and Mueller, F. Understanding Physical Activity through 3D Printed Material Artifacts. *In Proc. CHI '14*. ACM (2014). 3835-3844.

[5] Kuznetsov, S. and Paulos, E. Rise of the Expert Amateur: DIY Projects, Communities, and Cultures. *In Proc. NordiCHI'10*. ACM(2010). 295-304.

[6] Nissen, B., Bowers, J. Data Things – Digital Fabrication Situated within Participatory Data Translation Activities. *In Proc. CHI'15*. ACM (2015).

[7] Nissen, B., Bowers, J., Wright, P. et al. Volvelles, Domes and Wristbands: Embedding Digital Fabrication within a Visitor's Trajectory of Engagement. In *Proc. DIS '14.* ACM (2014). 825-834.

[8] Ogawa, H., Mara, M., Lindinger, C., et al. Shadowgram: A Case Study for Social Fabrication through Interactive Fabrication in Public Spaces. In *Proc. TEI'12*. ACM (2012). 57-60.

[9] Tanenbaum, J.G., Williams, A.M., Desjardins, A., and Tanenbaum, K. Democratizing Technology : Pleasure, Utility and Expressiveness in DIY and Maker Practice. In *Proc. CHI'13*, ACM (2013), 2603–2612.

[10] Vande Moere, A. Beyond the Tyranny of the Pixel: Exploring the Physicality of Information Visualization. In Proc. IV'08. IEEE Computer Society(2008). 469-474.