Inspired by Information: Using Data Visualization in Co-Design Workshops

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Abstract

The amount of data we generate has grown exponentially. This data has great value and is a rich source of inspiration for designers of interactive systems. In this paper we introduce research in which we use interactive visualizations to make this data accessible for participants in co-design workshops. Visualizations are explored during making activities and alongside creativity techniques as preparation for generative design. We illustrate our work with examples from a recent service design workshop before outlining some of the key challenges and opportunities present in our ongoing research.

Author Keywords

Data Visualization, Creativity Support, Co-Design

ACM Classification Keywords

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

General Terms

Human Factors, Design

Introduction

Computing systems are increasingly ubiquitous and as a result we are witnessing an exponential growth in the amount of data we generate. This data, whether it

Figure 1: Exploring the data visualization during a workshop

comes from social media posts, online transactions, GPS location signals or smart consumer products, can be deeply human with the capacity to capture snapshots of our everyday activities. Rich in information, this data also holds a wealth of inspiration for designers to tap into. For example, smart energy meters when used in association with smart electricity plugs can capture fine-grained detail about a household's energy use. This data has the potential to provide important insights to the individual household and when aggregated to inform powerful models of typical consumption for suppliers. A key question for us, as designers of interactive systems, is how can we realize this potential? How best can we reflect the needs and desires of the future users of the products and services we design?

Participatory Design Workshops
One method with which designers have found success in addressing the needs of the future users of the systems they design is participatory design workshops, in which future users and other stakeholders are included as partners. Using generative co-design techniques such as making narrative collages from ambiguous stimuli, Elizabeth Sanders has shown how this approach can be extended into the realm of experience and desire where participants' imagined futures are explored and realized as design ideas [7]. Similarly, creativity workshops in which representatives of key stakeholder groups undertake activities using creativity triggers, analogical reasoning and constraint removal have been shown to discover novel or unlikely requirements for complex socio-technical systems [4].

In this paper we introduce research in which we use interactive visualizations to make domain relevant data accessible as a resource for participants in design workshops. Here, visualizations are used in conjunction with making activities and structured creativity techniques in order to provide inspiration and support participants' preparation for generative design.

Data Visualization and Creativity in Design Workshops
Preparation is a key part of the creativity we seek to promote in design workshops. In his seminal four-stage model of the creative process, Wallas [9] describes how during preparation we are searching for relevant information and seeking a clearer understanding of the task or problem at hand. An effective preparation stage increases the likelihood that participants will be successful in the later illumination stage when ideas are generated and insight gained. Insight, it is often acknowledged, is also 'the purpose of visualization' [1]. We understand this to mean that through the visual exploration of data we can identify patterns, trends and unusual occurrences, and that this can lead to new and deeper understanding of the subject at hand. Such exploration and sense-making activities to us represent an archetypal example of the tasks Wallas describes as the preparation stage of creativity. We therefore see a clear link between the activities undertaken whilst seeking insight exploring interactive visualizations and those undertaken in preparation for creative design.

Based on this understanding we are developing novel workshop techniques in which domain relevant data is presented to participants using interactive visualization tools. These they explore as part of initial workshop activities that also utilize creativity techniques or involve making things with ambiguous stimuli. These activities are designed to encourage participants to explore not just the data as visualized but also the

Figure 2: Example of an 'imagined household' collage produced in our smart home service design workshop

wider context that the data comes from in order to gain a clearer understanding of the design task at hand. It is our aim that through these activities, participants gain insights both from factors explicitly represented in the visualization and also from exploring their existing knowledge and previous experiences.

Participants will normally undertake these workshop activities within groups. This reflects our understanding of creativity as a social process. These social aspects of creativity are a key part of Shneiderman's genex framework [8] with its relate stage in which one consults with peers and mentors. Throughout our workshops participants are encouraged to relate, to share and to build on each other's ideas. During exploration activities they relate their individual insights to fellow group members and typically workshop activities will end with groups taking turns to relate their ideas to the workshop as a whole. This means that during each workshop there are continuous cycles of data exploration and insight sharing, verification and idea development, making and design. This is a highly iterative and multi-layered process of creativity. The insights gained and ideas developed exploring visualizations during particular activities are cross-pollinated both within and between groups, before they are realized in design prototypes.

An Example Service Design Workshop
In early November 2012 we held a one-day design workshop in Milton Keynes, UK with energy provider E.ON. The purpose of this workshop was to outline potential new services made possible by the data generated from smart home energy products. This workshop had thirteen participants, eleven E.ON customers enrolled in a long-term trial of smart home

technology and two members of E.ON's smart home project staff. For this workshop we built an interactive visualization tool representing one week's energy use by a possible household. A model of typical energy consumption patterns was used to generate the data being visualized. Two workshop activities were designed during which participants explored the visualization, seeking insights in the data. These were the first two activities of the day.

Workshop Activities
In the first activity participants worked in small groups exploring the data visualization and seeking insights that would prompt them to imagine what the household it represented might be like. To describe their imagined household each group was given an A1 worksheet with areas for them to show the household members, the property, the type of energy consumer they might be, how they might feel about technology, their mealtimes and their means of transport. Participants then created collages outlining the household they imagined was represented by the energy consumption data. To help with this each group was also given a creativity toolkit made up of pens, post-its, colored paper shapes and around three hundred photographs of different people, buildings, means of transport, food and technology.

In the second activity each group again explored the data visualization this time looking for insights into how their imagined household could be smarter in their energy use. They then completed a competition entry form listing their top five suggestions. The competition was completed with a tiebreaker question in which each group was asked to suggest the smart home technology, either real or imaginary, that would most improve their imagined household's lives.

A further three activities took place during the workshop. In the third activity we asked participants to individually complete three reflective postcards. These were used to collect feedback for evaluation as described below. The fourth activity was a three-part divergent brainstorm with the workshop in a single group suggesting ideas for the data a smart home might generate and services that could utilize this data. In the final activity each group identified a single smart home service suitable for their imagined household and created three A1 collages that together formed a storyboard outlining this service at the point of sign-up, at the first time it was used and once it had become an accepted and regular part of their imagined household's lives. To create these collages they used the same creativity toolkits as earlier.

Evaluating Workshop Outputs
Following Warr and O'Neill's model of participatory design as a social creative process [10], we aim to evaluate our research in three key ways. First, we want to know how effectively we support a participant in their role as *The Creative Person*. Second, we want to understand the effect that introducing data visualization into workshop activities has on *The Creative Process*. Third, we want to know what impact exploring the visualization during workshop activities has had on *The Creative Product*.

Evaluating Support for The Creative Person
To evaluate how well our participants felt they were supported in their role as *The Creative Person* we asked them to complete three reflective postcards as outlined above. On each postcard we printed a prompt to elicit responses to our concerns regarding support for insight seeking and creativity (see side bars). We derived

these prompts from previous research studying the evaluation of creativity support tools [2] and how users seek insight when using visualizations [11, 6]. This proved an effective means of evaluation and our analysis of these postcards (see Table 1) indicates that participants felt engaged and supported during collaboration. Also that they felt able to build on their existing knowledge and that it was easy for them to gain an overview of the data and to find patterns or relationships within it.

Evaluating Support for The Creative Process
Prior to the workshop with E.ON we had undertaken a design experiment to assess the effectiveness of two different styles of visualization on participants' creativity. Here we had used a combination of observation and video analysis in conjunction with the outputs generated whilst exploring the visualization to evaluate support for *The Creative Process*. Whilst this is a suitable evaluation method for an experiment, we feel that assigning an observer to each group or videoing groups as they work is inappropriate for a public workshop. With this in mind our evaluation analysis was based on the outputs from the first two activities in which the visualization was being explored.

In our analysis of the outputs from the first activity we were looking for rich descriptions of possible households where different options had been explored and which contained a number of details relating to the context of their energy use. We found evidence that participants had been inspired by insights gained from the data but also that they drew on their existing knowledge and previous experiences. Because of this each group's household was different. Whilst they had picked up on similar aspects of the data, these had

Reflective Prompt 3

Please reflect on your understanding of the information contained in the data visualization. Write a few sentences, thinking in particular about how easily you managed to gain an overview of what was represented. Also think about how quickly you grasped what the information meant, did you spot clear patterns and relationships or did you find it confusing. Did it prompt you to think of ideas you had not previously considered?

been refracted through individual prisms and were realized in unique ways. Likewise, in our analysis of the competition entries from the second activity we found suggestions that were driven by insights in the data but which reflected the experiences and desires of our participants, whilst still being sensitive to the perceived lifestyle of their imagined household. Here we begin to see evidence that the information in the data visualization had inspired participants as they gained understanding in preparation for design.

Evaluating Impact on The Creative Product
The number and quality of ideas generated is often used to measure a *Creative Product* [3]. However, this measure has generally been applied to brainstorming or similar activities where ideas are collected individually. Counting the number and judging the quality of the individual ideas generated during the making of a collage is less straightforward. Here, many different ideas may be combined and included simultaneously and the quality or value of an individual idea may only be judged as part of the whole storyboard or prototype. Instead we based our evaluation on how well the ideas represented in the final service design could be traced back to individual insights gained during earlier activities in which the data visualization was being explored. We found evidence that the insights which had sparked the groups' initial ideas for a household and had led to suggestions for smarter energy use were key inspirations in their service design prototypes. These insights had subsequently been developed during the day's other activities and had further incorporated participants' own desires. Yet they still responded to the initial concerns uncovered during exploration of the visualization and strongly reflected the needs of their

imagined households. This is further evidence of an effective preparation stage prior to design.

Challenges and Opportunities

The evidence from our service design workshop with E.ON is promising. Responses to our reflective postcards show evidence that participants enjoyed using the visualizations and that data visualization can play a useful role in preparation activities during generative design workshops. The challenge now is to repeat these findings in other domains and using different types of data. To this end we are currently planning a study to investigate how visualizations of data generated in a residential care home can be used to help design systems that support dementia care workers in their creative problem solving.

Another key challenge we face in our research is that implied in the description of our evaluation methods. For our approach to be adopted in wider practice it is incumbent upon us to demonstrate that insights gained exploring data visualizations can inspire design ideas that are different in kind and of at least equal creativity as those inspired by other methods. Whilst we believe this to be the case, it is important to develop our evaluation methods so that we can more effectively trace the provenance of design ideas and see the influence of insights gained during preparation. We need to develop new evaluation metrics and further investigate the nature of insights gained exploring visualizations within workshop activities. Thankfully we are not alone and similar challenges relating to the in-depth evaluation of creativity support environments remain an ongoing interest for others in the CHI community [5].

Evaluation Factor	Positive	Negative
Engagement	13	0
Collaboration	12	0
Generating Ideas	0	1
Exploring Options	1	1
Building on Existing Knowledge	7	0
Patterns & Relationships	10	2
Overview	8	1

Table 1. Analysis of participant responses to the prompts on our reflective postcards

Alongside our public design workshops we will also undertake further design experiments to compare different visualization techniques and workshop activities. Here we will continue with comparisons of the effectiveness of pragmatic versus artistic styles of visualization, and with explorations of storytelling, role-play and game-based creativity techniques to see how visualizations can be integrated with these activities.

We started this paper with a statement regarding the exponential growth in the amount of data being generated and a question regarding how we, as designers of interactive systems, can help realize its potential. Such data, much of which is deeply human even when aggregated, is seen as increasingly valuable. In future the ethical treatment of this data may become a key concern for data-savvy users. We hope that by connecting people to the data they generate early on in the design process, by fostering a sense of ownership and value, and by utilizing their insight and creativity, then together we have an opportunity to realize designs that better reflect our needs and desires, using data to the benefit of us all.

Acknowledgements

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