Extended Abstract

Using Sketching to Support Visualisation Design

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Because it can be so useful, many people are motivated to create Information Visualisation software to address their own unique problems of understanding data. However, the techniques which visualisations use to enhance cognition of data are not widely known. Also, there are currently few resources which comprehensively describe a method for designing novel visualisations. Consequently, people who seek to build them are often left to consult guidelines and references models, which do not adequately describe how to design a new visualisation tool. Almost always, that design involves creativity and problem-solving. Based on our research, we argue that sketching aids these design objectives because it supports Communication, Creation, and Collaboration.

Information visualisation, visualisation design methodology, sketching

1. BACKGROUND

There are currently few methodologies which comprehensively describe creativity and problem-solving procedures for creating information visualisation tools. The discipline is currently laying the groundwork for such, as is evidenced by numerous guidelines, taxonomies, and recommendations for best practice, such as those offered by Shneiderman [6], Carr [2], and Rheingans and Landreth [4]. Also, there are a number of systems (e.g., Lange, et al. [3] and Salisbury [5]) which have attempted to automate the creation of visualisations and thus, to make concrete some of the procedural steps which are important. These tend to draw on Reference Models such as those offered by Card, et al. [1], which describe the major features of visualisation systems but do not account for the creative design process as it pertains to solving visualisation problems. Yet, building visualisation tools is a creative design process. Any proposed methodology should therefore account for creativity, ideation, and problem-solving, which are parts of that process. This knowledge is under-represented in the literature.

The current literature is comprised mainly of guidelines, example visualisations, and reference models. Reference models are the most detailed descriptions of visualisation systems, but they do not provide support for creating new visualisations, beyond describing what aspects of the system should be present. As a way to enhance guidelines, Visualisation Design Patterns [8] have been proposed as a structured set of knowledge about solutions for visualisation design problems. But such descriptions alone do not capture the characteristics of a “good” visualisation. The ethic that informs the design of visualisations is that a “good” visualisation will make data easier for the user to understand and learn from. Implicit in this notion is that visualisations should be easy to use. Thus, representation of the user is important in the design process. However, even though work in the Human-Computer Interaction community has shown techniques such as participatory design to be very effective for creating usable software, they are not discussed in the IV literature. Also, usability evaluations are rarely reported. Finally, there is very little discussion of the use of design techniques to support ideation and problem-solving. This absence is particularly surprising, considering that visualisations which offer creative visual representations, supported by usable interactions, receive the highest acclaim. Other disciplines have recognised that creativity and problem-solving are supported by sketching-out alternatives early in the design process. However, a design approach which supports sketching has not been examined by the visualisation community.

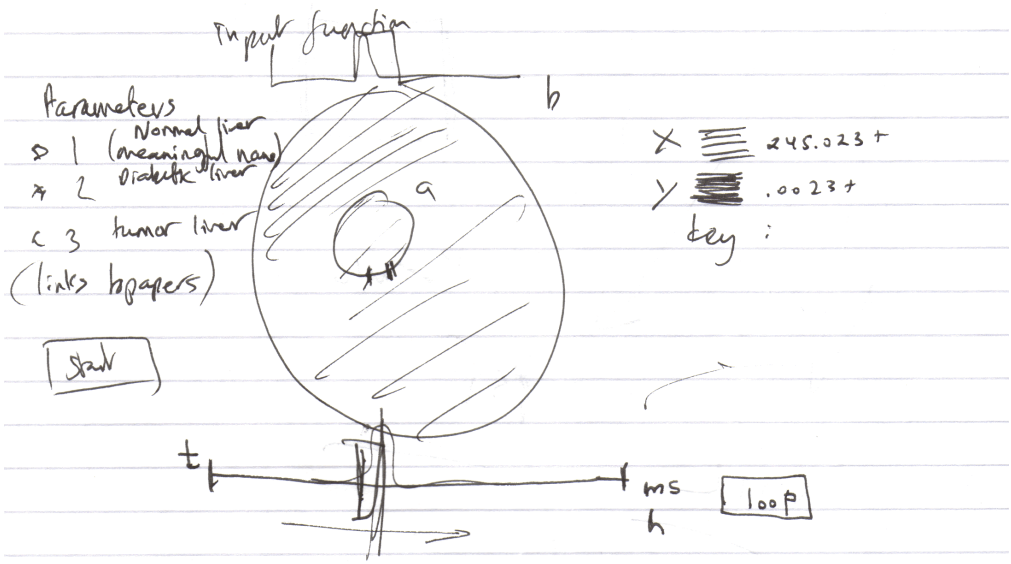

FIGURE 1: A design sketch of the "Model cartoons" visualisation module.

2. RESEARCH

To address these deficiencies, a Case Study was performed with a *bona fide* design problem in the domain of Computational Biology called the Beacon Project, at University College London. To address user representation in the design process, a participatory design approach as advocated by HCI research, was used. It engaged end-users, software engineers, and a visualisation specialist in an iterative design process over a period of several weeks. Design ideation and problem-solving were supported through sketching and team participation. Visualisation Design Patterns were used to provide the design team with knowledge about effective visualisation techniques.

Analysis of the design work was performed using the theory-building qualitative method of Grounded Theory [7]. Drawing from the audio recordings, design sketches, and follow-up discussions, we have identified three categories of activity that sketching facilitated: Communication, Creation and Collaboration. These categories emerged from the many different ways that team members used sketching in the design process. The results of the study were that, in this case, visualisation designers benefited from taking a participatory design approach which incorporated the use of existing design knowledge with techniques that supported ideation and problem-solving. The participatory approach kept the users actively engaged in the design process and put a high importance on their input. Using sketching as a design technique enhanced communication, creativity, and collaboration within the team. Use of the visualisation design patterns allowed the group to benefit from existing information visualisation design knowledge during the creation their visualisation designs.

Perhaps the most significant benefit that sketching brought to the design process in this case study was enhanced Communication. One of the most difficult parts of designing in groups is ensuring that everyone understands the complex issues under discussion. Sketching helped to communicate new ideas quickly, to support verbal communication, to confirm understanding, to form a written record for later reference, to build complex ideas, and to explain difficult concepts.

Another of the major benefits that sketching brought was enhanced Creativity. It allowed people to take ideas in their head and to try them out on paper. This creativity-through-drawing process is well recognised in the fields of graphic communication and architecture, but has been little addressed in visualisation engineering. In this study, sketching aided creative problem-solving, creation of abstractions and mnemonics, and design of novel widgets.

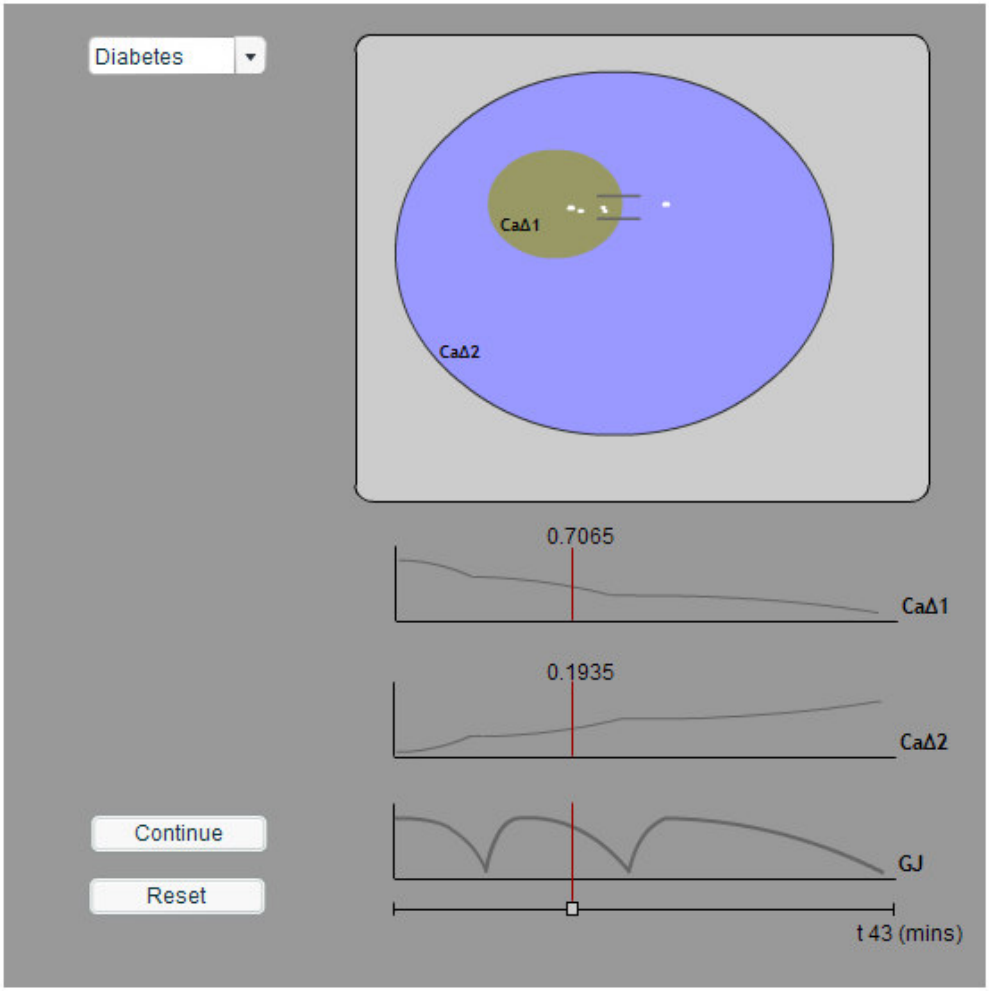

FIGURE 2: A prototype of the "Model cartoons" visualisation module.

The third major way that sketching facilitated the design process was by helping people to work together. Each of the participants brought his or her unique ideas to the design process, and needed to share them with others. By actively sketching these ideas with others, group input and ideation was made possible. Indeed, there were many points when two or more participants were actively sketching on a common work area together as they played with design ideas. Sketching further supported Collaboration by allowing team members to create scenarios from which to elicit feedback and participation of others. Sketching also triggered understanding among designers which allowed them to build on one another's ideas.

The results of this work were the description of eight software visualisation modules for assisting systems biologists on the Beacon Project. One of these modules, called "Model Cartoons", was selected as a good candidate for a software prototype. One of the difficulties in the Beacon Project involves the determination of whether computational models of liver metabolism accurately reflect the activity of real liver cells. These complex models are difficult to interpret. The project team felt that the results of the models would be more easily understood if they could be presented visually, rather than as tables of numbers. In particular, the Biologists on the team wanted to be able to view and control a representation of a biological process, whilst preserving the ability to refer to the charts containing the source data. Also, a prototype was seen as a potentially valuable tool for demonstrating results to stakeholders and colleagues.

The Model Cartoons prototype allows interactive exploration of a biological process wherein glucose in the human liver is metabolised within the cellular structure and among neighbouring liver cells. Figure 1 shows one of several original sketches used to design the Model Cartoons module. The significant features in this sketch can be compared to the features that were included in the prototype (Figure 2). The large circles representing a cell and its nucleus are clearly visible in the prototype. The sketched parameters “Normal”, “Diabetic”, and “Tumor” have been implemented as a drop-down menu based on decisions made by the design team which were facilitated by the sketching process. Sketched ideas such as the control timeline (bottom) and data labelling have been used for the prototype, with slight modifications. Each of these interface controls and widgets were arrived at through an exploratory, and participatory process where sketching played a significant facilitating role.

Sketching sided Communication, Creativity, and Collaboration, which then led to the production of this sketched design over a period of several design sessions. The team determined that they would not have been able to arrive at such a design prototype without the use of sketching and visualisation design patterns as part of the design process. They are currently in the process of implementing a usability study to assess whether the model better communicates the metabolic process represented by the Model Cartoons visualisation, thereby helping systems biologists.

3. SUMMARY

The results of this case study in information visualisation design were that the use of sketching as an integral part of a collaborative design process aided creativity, communication, and collaboration. These findings show promise for use of sketching to augment other design methodologies for Information Visualisation.

Because the case study was qualitative in nature, any generalisations to other visualisation design cases should be circumspect. However, the large quantity of literature in other design disciplines such as architecture and engineering tends to support the hypothesis that the design method used in this study will be effective for other visualisation design problems. It is hoped that, in future, the results from this work will contribute to the development of more complete descriptions of information visualisation design methodology.

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