City Research Online

City St George's, University of London

Citation: Rooney, C., Beecham, R., Dykes, J. & Wong, W. (2017). Dynamic Design Documents for supporting applied visualization. Poster presented at the IEEE VIS 2017, 01 - 06 Oct 2017, Phoenix, USA.

This is the published version of the paper.

This version of the publication may differ from the final published version. To cite this item please consult the publisher's version.

Permanent repository link: https://openaccess.city.ac.uk/id/eprint/19479/

Copyright and Reuse: Copyright and Moral Rights remain with the author(s) and/or copyright holders. Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge, unless otherwise indicated, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way. For full details of reuse please refer to City Research Online policy.

City Research Online: http://openaccess.city.ac.uk/ publications@citystgeorges.ac.uk

Dynamic Design Documents for supporting applied visualization

Chris Rooney *
Middlesex University, UK

Roger Beecham †
City, University of London, UK

Jason Dykes‡
City, University of London, UK

William Wong§
Middlesex University, UK

Abstract

A common characteristic of applied visualization is collaboration between visualization researcher and domain expert – where the visualization researcher attempts to assimilate sufficient detail around data, task and requirements to design a visualization tool that is manifestly useful. We report on a method for enabling such a collaboration that can be used throughout the design process to gather and develop requirements and continually evaluate and support iterative design. We do so using highly interactive web-pages that we term *dynamic design documents*. Applied during a four-year visual data analysis project for crime research, these documents enabled a series of data mappings to be explored by our collaborators (crime analysts) remotely – in a flexible and continuous way. We argue that they engendered a level of engagement that is qualitatively distinct from more traditional methods of feedback elicitation, offered a solution to limited and intermittent contact between analyst and visualization researcher and speculate that they provided a means of partially addressing certain intractable deficiencies, such as social desirability-bias, that are common to evaluation in applied data visualization.

1 Introduction

Applied or problem-driven visualization usually requires some collaboration between Information Visualization researcher and *front-line analyst* [5]. Close engagement with *front-line-analysts* during the early stages of a project allows researchers to learn important detail about previously unfamiliar datasets and analysis routines. As an applied visualization study progresses, *front-line-analysts* are called upon to perform analysis, test techniques and evaluate proposed visual analysis tools against previously identified analysis routines as designs and requirements develop, data are explored and ideas are generated.

In such examples of 'visual design methodology', domain experts tend to contribute heavily during problem specification and visualization tool evaluation but less so during visual design. Recent examples of applied visualization have demonstrated that the distinction between visualization researcher contributing new designs and domain expert contributing subject-matter expertise can be dissolved [7], with *front-line-analysts* playing a far more active role in the design process and the visualization researcher also generating new domain-relevant knowledge [3]. Fuller interaction between domain expert and visualization researcher, particularly during the design phase, has been achieved through, for example, creativity workshops [2].

Inspired by interactive stories published within data journalism[1,2], we report on an alternative approach whereby design ideas are communicated to domain experts using *dynamic design documents* (DDDs). Rather than constraining the process of domain user engagement to single events, these highly interactive web-pages can be navigated by analysts in a setting with which they are familiar and through a process of guided exploration, interaction and play. As well as describing our use and design of DDDs, we reflect on the level and quality of feedback that was elicited from engaging analysts in this way.

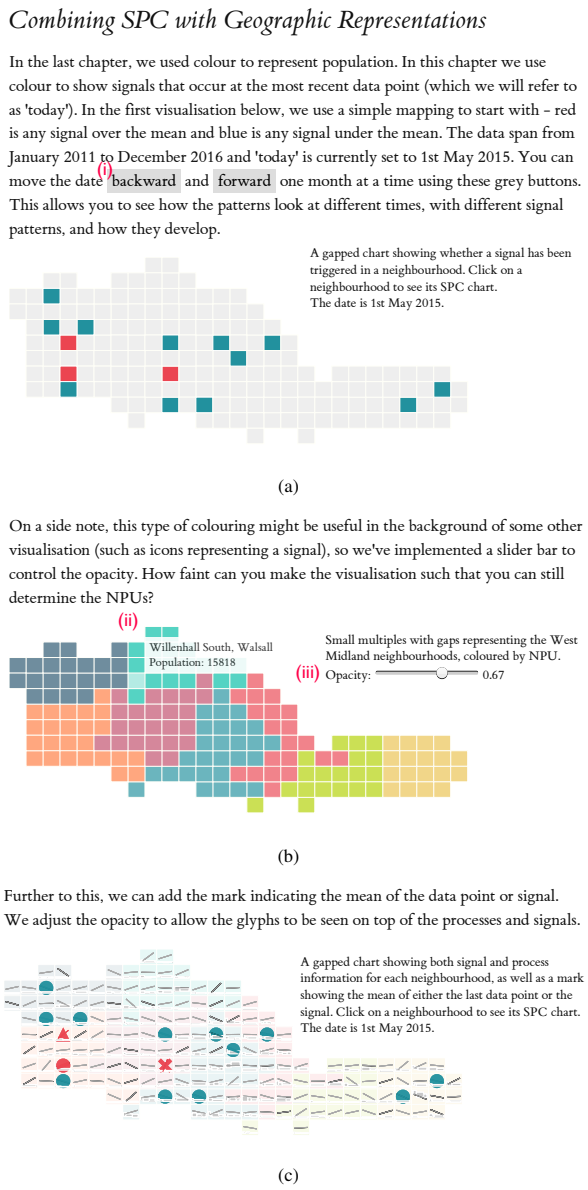

Figure 1: Three excerpts from our interactive documents. Interactive features include (i) buttons inline with text for controlling date ranges, (ii) hover for additional information, and (iii) a slider to control opacity levels.

*e-mail: c.rooney@mdx.ac.uk
†e-mail:roger.beecham@city.ac.uk
‡e-mail:j.dykes@city.ac.uk
§e-mail:w.wong@mdx.ac.uk

[1] http://nyti.ms/2nBpk3o, last accessed 31st March 2017
[2] http://bbc.in/2eTznsH, last accessed 31st March 2017

2 Dynamic Design Documents

An excerpt from our DDDs is in Figure 1 and a full set of documents can be viewed at `https://rooch84.github.io/spc/`.

Our DDDs communicate an ensemble of redesigns, or visualization 'make-overs', of Statistical Process Control Charts (SPC). SPC monitoring is an established technique that combines statistical theory and visual methods to identify exceptional activity, in this case exceptional levels of crime given historical data. The proposed redesigns allow our collaborators (crime analysts) to identify geospatial patterns in the 'signals' implied by SPCs. They do so by abstracting some of the detail from default SPC charts with which analysts are familiar (Figure 1) and by carefully mapping key data properties – SPC signals and processes – to visual channels.

In traditional applied visualization, researchers tend to present incremental versions of self-contained tools. When demonstrating these tools to domain collaborators, it is very easy to focus on interaction features and usability concerns instead of design. Our DDDs aim to articulate the design process as a narrative, demonstrating deficiencies in existing data mappings as a means of explaining and justifying often new and unfamiliar encodings. We append both new and modified designs to the narrative, providing a provenance trail for our redesign.

A challenge in applied visualization is around persuading *front-line analysts* of a new visual grammar, where the benefits conferred by that new encoding may not be obvious [5]. By exploring the redesigns independently using DDDs, we hoped that analysts would understand and form a view of the new data mappings, as well as develop a sensitivity to the trade-offs involved in engineering greater data density.

Since spatial analysis of SPC signals motivated the redesign, our DDDs first demonstrated and encouraged *front-line analysts* to explore the spatial layouts used to overlay neighbourhood-level signals in their approximate spatial location. Our DDDs supported *de facto* interactions, such as hover for additional information. By mousing over individual spatial units and visually scanning across conventional and abstracted spatial layouts, *front-line analysts* were able to learn and also critique our new layout, which was derived algorithmically [4].

A further ambition was to encourage analysts to reason critically about SPC methodology given our redesigns. We engineered very particular interactions in order to effect this thinking – placing textual overlays and interactions at certain key moments of our design descriptions, styling these sections of the text in a way that suggested interactivity [1].

We used the d3 visualisation library for implementing our designs. Our intention was to create interactive markdown using Glasseye[3], but a lack of control over the visualizations led us to create our own interactive documents manually using HTML, CSS, and JavaScript. We use Edward Tufte-inspired CSS styling[4] to our documents [6], which can be seen in Figure 1. This styling provides clarity and carries authority, whilst suggesting some informality that we hoped would encourage experimentation and feedback.

3 Discussion

We found engaging analysts through the use of DDDs to be highly instructive. Our collaborators commented that the descriptions of design rationale accompanied with interactive examples '*demonstrated the thinking process*'. That these documents made transparent the incremental nature of our re-designs, and the genesis of specific design decisions, was a particularly positive outcome. Revealing this process gradually meant that analysts were more confident in interpreting more detailed composite views, which they acknowledged at first glance '*tend to overwhelm*'.

We speculate that the documents enabled a level of engagement that was qualitatively unique from earlier design study projects in which we have participated. By physically separating and distancing researcher and collaborator, analysts were able to explore designs over several days. This freed analysts from the pressure of providing immediate responses or from exposing the fact that they might not immediately understand our redesigns. We detected a slight change in role – something close to a blurring of 'domain expert' and 'visualisation expert' similar, but in the opposite direction, to that observed by Wood *et al.* [7] and in line with the mutual influence described by McCurdy *et al.* [3]. Perhaps due to a deeper understanding of the design process, analysts began to make considered and well-justified design suggestions rather than simple feature requests. These interventions generated interesting discussion and that such discussion took place is evidence of the level of agency collaborators felt over the designs. Analysts also began to question established standards, using a vocabulary and justification informed by visual design principles that were only ever *implied* by our redesigns.

There was a material difference in the feedback elicited through analysts annotating DDDs and from teleconference calls scheduled to discuss our redesigns. In the annotations, analysts expressed well-qualified scepticism around certain abstractions, particularly in our more detailed composite views. Such scepticism was not expressed in the teleconference. We speculate that this difference in opinion may to an extent relate to effects familiar to empirical social science: for example, social-desirability bias, where individuals respond in ways that they perceive will be viewed positively by others.

We are still exploring the use of DDDs, but initial experiences suggest they may help engender focus and substance in applied visualization. In particular, we consider them to support tight and effective working between analyst and visualization researcher.

[3] `http://bit.ly/2nRm0hE`, last accessed 31st March 2017

[4] `http://bit.ly/2nJrjmI`, last accessed 31st March, 2017

Acknowledgments

This research was in part supported by the EU under the EC Grant Agreement No. FP7-IP-608142 to Project VALCRI, awarded to Middlesex University and partners. The authors wish to thank colleagues at West Midlands Police (UK) for their ideas, continued interest and engagement.

References

[1] J. Boy, L. Eveillard, F. Detienne, and J. D. Fekete. Suggested interactivity: Seeking perceived affordances for information visualization. *IEEE Transactions on Visualization and Computer Graphics*, 22(1):639–648, Jan 2016. doi: 10.1109/TVCG.2015.2467201

[2] S. Goodwin, J. Dykes, S. Jones, I. Dillingham, G. Dove, A. Duffy, A. Kachkaev, A. Slingsby, and J. Wood. Creative user-centered visualization design for energy analysts and modelers. *IEEE Transactions on Visualization and Computer Graphics*, 19(12):2516–2525, Dec 2013. doi: 10.1109/TVCG.2013.145

[3] N. McCurdy, J. Dykes, and M. Meyer. Action design research and visualization design. In *BELIV '16 Proceedings of the Sixth Workshop on Beyond Time and Errors on Novel Evaluation Methods for Visualization*, pp. 10–18. Baltimore, ML, USA, 2016.

[4] W. Meulemans, J. Dykes, A. Slingsby, C. Turkay, and J. Wood. Small multiples with gaps. *IEEE Transactions on Visualization & Computer Graphics*, 23(1):381–390, 2017.

[5] M. Sedlmair, M. Meyer, and T. Munzner. Design study methodology: Reflections from the trenches and the stacks. *IEEE Transactions on Visualization and Computer Graphics*, 18:2431–2440, 2012.

[6] E. R. Tufte. *Visual Explanations: Images and Quantities, Evidence and Narrative*. Graphics Press, Cheshire, CT, USA, 1997.

[7] J. Wood, R. Beecham, and J. Dykes. Moving beyond sequential design: Reflections on a rich multi-channel approach to data visualization. *IEEE Transactions on Visualization and Computer Graphics*, 20(12):2171–2180, Dec 2014. doi: 10.1109/TVCG.2014.2346323