# A Design, Analysis and Evaluation Model to Support the Visualization Designer-User

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**ABSTRACT**

Existing visualization design and evaluation frameworks rest on a distinction between the designer and the user. However, there is little explicit guidance on design, analysis and evaluation when the designer *is* the user. A simple solution to this problem is for the researcher (who combines the designer and user roles) to be clear about which activity they are conducting at which point in time. To support the researcher, we propose a design, analysis and evaluation model. This model complements existing visualization design and evaluation frameworks. We have adopted this model in our ongoing research into uncertainty in crowdsourced crisis information.

**Index Terms:** D.2.2 [Software]: Software engineering—Design tools and techniques

## 1 INTRODUCTION

The literature on visualization evaluation is increasing in size, especially as arguments are made in favour of qualitative methods [6], alongside their more established quantitative counterparts. Several authors have offered guidance on selecting appropriate methods by proposing evaluation frameworks. For example, Munzner describes a nested model within which a visualization, or an aspect of a visualization, is located at one of four levels (the focus level); at each level, appropriate immediate and subsequent evaluation methods are identified [14]. An advantage of this model is that it highlights how the validity of a visualization may be threatened at three other levels, not simply at the focus level. In contrast, Lam et al. take a scenario-based approach within which seven common evaluation scenarios with appropriate evaluation methods are described [9].

Common to the nested model and the scenario-based approach is a distinction between the designer (who conducts design and evaluation) and the user (who is based in the problem domain and conducts analysis). This distinction is also found in user-centred approaches to visualization design. For example, both Lloyd and Dykes [10], and Koh et al. [7] discuss collaborative models of the design process. However, whilst it is acknowledged that user-centred approaches are required to 'bridge the gaps' between designers and users [18], there is little explicit guidance on design, analysis and evaluation when the designer *is* the user. This is surprising, as van Wijk argues that personal curiosity can lead to advances in terms of design and analysis [18]. Furthermore, geovisualization can be conceptualised as facilitating exploration in a private context (rather than confirmation in a public context) [11]. It is not unreasonable to assume that within this context, the designer and user roles could be combined.

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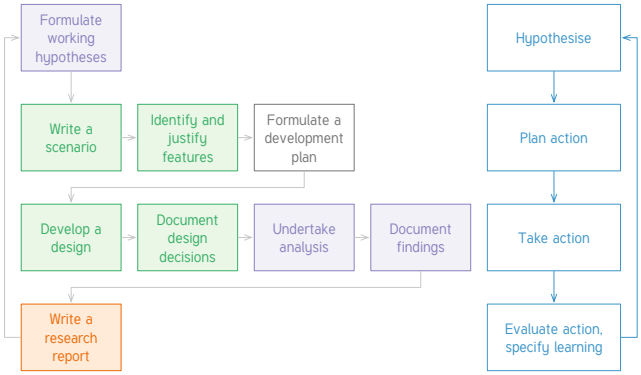


Figure 1: A design (green), analysis (purple) and evaluation (orange) model. The cyclical action research process [17] is shown to the right (blue).

## 2 A DESIGN, ANALYSIS AND EVALUATION MODEL

The distinction between design activity and analysis activity is an important one. For example, consider the claim that a design led to an insight: a design study is suggested by the nested model and the scenario-based approach as an appropriate means of justifying this claim [14, 9]. For this claim to be valid, design activity should precede analysis activity (although design activity can be iterative [10, 7]). If it did not, then it would be hard to argue that the design *led* to the insight. Clearly, it is easier to argue that design activity preceded analysis activity when the designer and the user are different people: there is a clear break between the design process (or one iteration thereof) finishing and the analysis process (or one iteration thereof) starting.

In many cases the designer and the user are the same person (for example, Slingsby et al. [16] discuss design of, and Wood et al. [19] discuss analysis with, hierarchical layouts). In these cases the researcher (who combines the designer and user roles) may benefit from being clearer about which activity—design or analysis—they are conducting at which point in time. To support the researcher, we propose a design, analysis and evaluation model that is informed by scenario-based design [15] and action research [17] (Figure 1). Like autoethnography, this model encourages structured reflection and externalises the 'internal dialogue' of design [5]. However, it has a stronger scientific basis [17] and, like other forms of critique, is based on evidence [8]. We have adopted this model in our ongoing research into uncertainty in crowdsourced crisis information [4].

In scenario-based design, a scenario describes how a user interacts with a system [15]. A scenario helps the designer identify features of a system; the designer can then make claims about these features, where a claim establishes a causal relationship between a feature and its positive and negative psychological consequences [3]. Scenarios can be seen as stories or design proposals [2], and may be grounded in practice [12]. In our ongoing research we treat scenarios as design proposals. Importantly, we also substitute

claims for justifications as the risks that a feature has negative psychological consequences are reduced when the user and designer roles are combined. Like claims, justifications are grounded in the literature. However, justifications do not establish causal relationships (Figure 2).

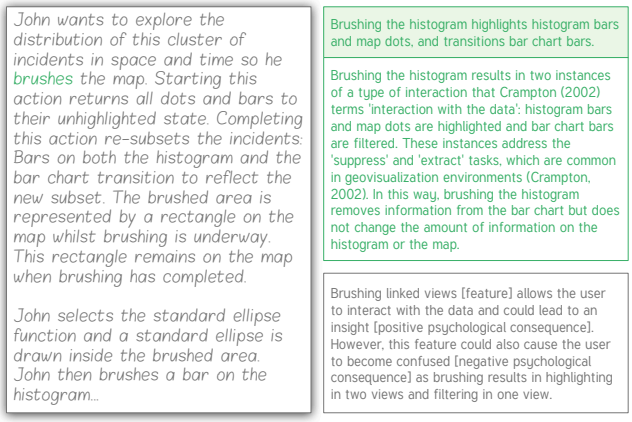


Figure 2: A scenario fragment (left) with feature and justification (top right), and claim (bottom right).

We situate scenarios, features and justifications within a cyclical action research process of hypothesising (diagnosing), planning action, taking action, evaluating action and specifying learning [17] (Figure 1). We begin a research cycle by hypothesising; that is, we formulate working hypotheses (an analysis activity). We then plan action, where we write a scenario and identify, and justify, features (design activities). We also formulate a development plan. We then take action, where we develop a design and document design decisions (design activities), and undertake analysis and document findings (analysis activities). Finally we evaluate action and specify learning (an evaluation activity); we write a research report where we reflect on the research cycle. Reflection is directed 'inwards' towards future research cycles (for example, new working hypotheses that lead to new requirements on the design) and 'outwards' to the research community [1].

In the language of the nested model [14], our design, analysis and evaluation model allows immediate and subsequent evaluation of the visual encodings and interactions (the design) in a form that is more open to scrutiny by other researchers. In this way, whilst potential threats to the design from ineffective problem domain characterisations and abstractions are reduced when the designer is the user, working hypotheses, scenarios, features and justifications still allow the reader of a design study to assess the degree to which a design solves a problem in a domain [13]. Furthermore, the researcher may also claim that a design led to an insight, again, in a form that is more open to scrutiny by other researchers.

## 3 Conclusion

We propose a model to support visualization design, analysis and evaluation when the designer and user roles are combined. This model encourages the researcher to be clear about which activity they are conducting at which point in time, in a form that is more open to scrutiny by other researchers. This model complements existing design and evaluation frameworks. We have adopted this model in our ongoing research into uncertainty in crowdsourced crisis information.

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