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# Critical InfoVis: Exploring the Politics of Visualization

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## Abstract

As information visualization is increasingly used to raise awareness about social issues, difficult questions arise about the power of visualization. So far the research community has not given sufficient thought to how values and assumptions pervade information visualization. Taking engaging visualizations as a starting point, we outline a critical approach that promotes disclosure, plurality, contingency, and empowerment. Based on this approach, we pose some challenges and opportunities for visualization researchers and practitioners.

## Author Keywords

Information visualization; critical theory; values.

## ACM Classification Keywords

H.5.2 [Information Interfaces & Presentation]: Misc.

## Introduction

A growing number of information visualizations are aimed at engaging citizens around a wide range of social issues. Such visualizations are typically created with the intention to raise awareness and outline visions for change. This development is encouraging for the research community, as it shows how visualization becomes part of our cultural repertoire. However, we see non-trivial questions for information visualization design and research. Visualization can help portray complex issues, which in

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## Author Preprint Version

The definitive published version is available at:  
<https://doi.org/10.1145/2468356.2468739>

Cite as:

Dörk, M., Feng, P., Collins, C., & Carpendale, S. (2013). Critical InfoVis: exploring the politics of visualization. In CHI'13 Extended Abstracts on Human Factors in Computing Systems (pp. 2189-2198).

turn can support civic engagement. However, visualization can also be used to obscure. Emphasis and omission are powerful techniques to reveal specific patterns in a dataset. Choosing what is highlighted will be affected by the designer's values and intentions. As visualizations continue to grow in importance, there is a need to think more systematically about how values and intentions shape visualization practice.

In this paper, we build upon critical perspectives in human-computer interaction and beyond to better understand the ability of interactive visualizations to influence, manipulate, and empower. Our goal is to develop a critical approach that examines the intentions behind visualizations and explores possible implications of their use. By outlining such an approach we aim to initiate a constructive discussion among researchers and designers about the power of information visualization.

### **An Overview of Critical Approaches**

Before elaborating what a critical approach for information visualization might look like, it is useful to look at critical approaches in related areas. The term 'critical' has been used in a number of fields to denote normative approaches. In social theory, for example, 'critical theory' usually refers to the analysis of long standing social problems, with an aim to both explain and transform society [14]. Critical theory often deals with issues of power (including issues of class, race, gender, identity, and political-economy) and challenges taken-for-granted assumptions about the world [7]. This kind of theory is 'critical' in the sense that it does not take the world as given, but questions the world and the place of theory within it.

### *Critical Theories of Knowledge*

Critical approaches are typically reflexive about the tools, methodologies, and theoretical frameworks they employ. Recognizing that knowledge is always partial and situated [12], these approaches pay attention to the ways in which data is gathered, interpreted, and communicated. 'Critical' in this sense means being aware of values and assumptions embedded within one's discipline.

In pedagogy and geography theorists and practitioners have successfully created approaches that link critical theories of knowledge with critical practices in the world. Critical notions of pedagogy challenge the supposed neutrality of education and chart a path that is not "imprisoned in the circle of certainty", but liberated by the critique of social conditions [8]. Rejecting oppositional teacher-student relations, critical pedagogy eschews ideas such as "The teacher knows everything and the students know nothing" to instead empower students to question dogma, investigate for themselves, and "connect knowledge to power and the ability to take constructive action" [11]. Critical pedagogy encourages students and teachers to engage in a dialogue, a relationship of mutual trust, hope, and critical thinking.

Critical geographers challenge neutral concepts of scientific enquiry and reveal the influence of implicit assumptions on our view of the world. Since maps can be viewed as constructions similar to text, they also offer diverse possibilities for interpretation. To go beyond the literal aspects of a map, deconstruction can be seen as a strategy to read "between the lines of the map" and examine hidden intentions [13]. Such a strategy can help to question processes of selection, simplification, and symbolization—which are necessary to make useful maps, yet can also be used to lie and manipulate [19].

### *Critical Considerations in Computer Science*

Analogous to the critical approaches in pedagogy and geography, critical approaches are also forming in computer science, in particular with regard to research practice and the role of values in technology design. While there is no clear definition of critical computing, there are various attempts to examine the assumptions and implications of computing technology and research. For example, Agre promotes the development of a *critical technical practice* that provides a space for reflection on a field's premises and methods [1]. Stahl and Brooke underline that a critical perspective can not only improve our understanding of systems, but emphasize values such as equality and emancipation during design [24].

Critical perspectives can be introduced at different stages. First one can consider the people involved and affected, the values and principles considered, and the intended and possible consequences of a technology [2, 10]. During realization, it is possible to critically examine how functional characteristics of a given artefact target particular groups or activities [3, 10, 23]. Once an artefact is used, the social context can be examined, for example, to see how gender roles and ethical values unfold [3, 10], and how appropriation changes the artefact's intended use [6]. As information technology becomes an integral component of our culture, researchers and designers increasingly explore the role of digital artefacts in our everyday lives asking "what values, attitudes, and ways of looking at the world" they may encourage or inhibit [23]. This concern is not about malicious intents, but rather unanticipated consequences and mismatches between the values of designers and the needs of the people using the technology [3]. It has been argued that corporate visions for technology often fail to recognize alternative uses and "rich narratives that challenge the conformity of everyday

life" [6]. Vibrant communities of digital artists and amateurs have evolved around tinkering, hacking, and customizing—activities all of which are largely at odds with the readymade culture of the computer industry.

To bring technical and cultural considerations together, technology design should explicitly consider ethics, values, and bias. In this direction *value-sensitive design* takes "an active stance toward creating computer technologies that [...] we can and want to live with" [9]. Considering values, assumptions, and alternative uses throughout the design process will not answer all ethical questions, but can give rise to designs that integrate diverse values and innovative research on values in technology use.

### **Alternative Voices in InfoVis**

With recent developments such as artistic [25], casual [21], and narrative [22] visualization, the traditional boundaries of information visualization have started to expand. We now summarize these activities in regards to the critical approach we wish to formulate.

*Artistic* uses of visualization have grown with the increasing availability of accessible graphics tools and open datasets. Unlike scientists' aspiration to find universal truths, artists have no illusion that the visualizations they create are neutral or universally true. Instead, they use visualization to encourage an impassioned reading of a subject matter [25]. However, this does not imply that artistic visualizations are not recognizable [16]. Artistic visualizations often involve personal experiences, individual opinions, and the context of the viewing experience in the interpretation.

Building on journalistic techniques of storytelling with data, Segel and Heer describe methods by which visualizations can act as *narratives* [22]. They propose that storytelling using visualization exists on a spectrum

between author-driven and reader-driven approaches. The notion of an author-driven narrative visualization acknowledges the non-neutral role of the designer, and a reader-driven approach relates to reader engagement. Hullman and Diakopoulos present a rhetoric framework for narrative visualizations that includes design choices about the dataset, visualization, and interactivity as well as 'extra-representational' factors on how a visualization may be interpreted [15]. In our work, we continue this effort to understand how possible interpretations might be favoured by taking a closer look at issues of values and power.

One way to empower visualization viewers is to let them create their own visualizations. A primary example is the community site Many Eyes, which is a form of *participatory visualization* [27]. This leads to unexpected uses, engaging conversations about data, and sharing of conclusions about data-related issues of societal importance. However, just as Excel has drawbacks in its limited selection of available views and false feeling of customization through changing visual styles [17], existing participatory visualization systems offer only a limited collection of visualizations and customization methods.

The notions of *casual* [21] and *vernacular* [26] visualizations highlight non-traditional uses and origins of information visualizations. In both cases, the purpose of visualization is not so much to gain 'analytic insight', but rather to get a heightened recognition of an issue, awareness about an online community's shared resources, or even reflection about oneself. The rise of casual and vernacular visualization is a testament to the growing significance of visualization beyond professional confines. A critical approach to visualization is in part triggered by these developments, especially with regard to the implications for civic engagement and activism.

## Principles for a Questioning Lens

Similar to a photograph's relationship to reality, visualizations do not capture reality as found in data but rather present a particular angle on it. Depending on the intention of the designer, visualizations can be used to influence, manipulate, and empower viewers in many ways. The range of interpretations of a visualization depends on both the designer and the viewer. Hence, the basic premise of our critical approach is that all visualizations are to some extent subjective and interpretive. There is no 'one' visualization that captures all aspects of a particular dataset from all possible perspectives. This is not to deny reality, but rather to confirm that visualizations are always situated and particular to the assumptions of their designer as well as the context of the viewer.

Following this premise, we propose a critical approach to information visualization that promotes disclosure, plurality, contingency, and empowerment. We have derived these principles by synthesizing values advocated by critical approaches in related domains and recent developments in visualization. We do not claim these principles to be authoritative, but rather a starting point for exploring issues of power in visualization.

**Disclosure.** Creating visualizations involves a range of decisions about data, representation, and interaction. Disclosing some of these decisions is a way to establish trust between visualization creators and viewers. When the designer's intentions and decisions are concealed, it is difficult to trust a visualization and engage with the presented issue. While one may never be fully aware of one's assumptions, disclosure describes the aspiration to be conscious of their potential effects and invite the viewer into exchanges with the designer, reflections about the visualization, and engagement with an issue.

**Plurality.** Since no one visualization can capture all perspectives on a phenomenon, exposing multiple facets and enabling a variety of interpretations is preferable to limited views and singular readings. For example, one can consider how the perspectives of the people involved are represented. If there are main lines of argument, one can examine which perspectives are emphasized or hidden. It is feasible to expose marginal, unconventional, and challenging angles on an issue as an attempt to help the viewer to reflect on their own assumptions. There may be situations in which the visualization designer deliberately chooses to advocate a specific standpoint instead of offering a nuanced set of perspectives.

**Contingency.** Instead of pre-determined conclusions to be drawn from a visualization, tools should provide for a range of possible ways viewers experience a visualization and make sense of a given issue. Since visualizations can change depending on the context of the viewer, it is possible to design a visualization that acknowledges the situation of the viewer in relation to the phenomenon being represented. Instead of providing fixed and unchanging views, flexible visualizations can engage viewers more deeply with a given issue and relate it to their life. By considering both viewer and phenomenon to be dynamic, contingent visualizations can provide room for more unique and profound experiences and insights.

**Empowerment.** Information visualization enable visualization creators to let their voice be heard and perspective been seen. Empowering visualizations should also allow viewers to question visual representations, utilize them to tell their own story, and shift from awareness to action. There may be a tension between the empowerment of visualization designers and creators. Interactivity can be provided to let the viewer steer data transformations such as selections, omissions, and

emphases. Empowering visualizations help people interact with one another, and make linkages across different backgrounds, and connect visualizations with actual civic engagement. In a critical approach, the designer attempts to be aware of their own power and who is being empowered by the visualization, and conversely, who may be excluded due to issues of access to technology, literacy, perceptual abilities, gender, and other forms of oppression.

These principles do not provide checklist-criteria to deem visualizations good or bad. Instead they allow us as designers, viewers, and researchers to formulate questions during the design, use, and study of information visualizations. With these principles we can examine the relationships between data and visualization, situation and activities, and designer and viewer.

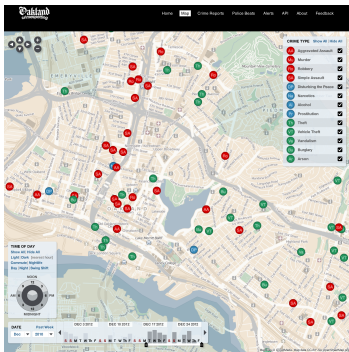
## Engaging Visualizations

In the following, we use the principles outlined above as a critical lens on three visualization projects that are aimed to inform and engage citizens around civic issues.

**Oakland Crimespotting** by Stamen Design [18] visualizes urban crimes in Oakland, California as small, coloured circles on an interactive city map (see Fig. 1). The map can be filtered by crime type, time of the day, and a bar chart of crimes committed per day.

*Disclosure.* The site has several accompanying articles that make clear the intent behind the project and also the assumption that exploring crimes along different criteria improves one's understanding of urban crime and thus contributes to an informed citizenry. The creators also detail some design decisions, which allows the viewer to comprehend how and why the views are generated.

*Plurality.* The data is arranged by location, date, time, and type of crime. However, the visualization does not allow the viewer to explore admittedly difficult questions

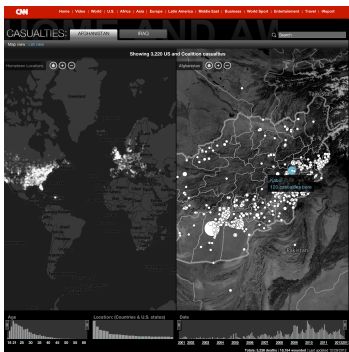


**Figure 1:** Oakland Crimespotting places crimes on the city map and provides interaction techniques to filter the crimes and access details [18].

concerning reasons, circumstances, and experiences of the people involved and affected. A visualization of crime that included background stories by victims, offenders, and witnesses could support a more holistic understanding possibly leading to a more nuanced dialogue about crime.

*Contingency.* The site's underlying data is regularly updated using data from the Oakland police department, keeping the visualization current and allowing people to view the visualization in context of local news. As noted on the about page, a map-first approach was chosen to let people relate to the data using their home, workplace, or school as entry points for their exploration of crime.

*Empowerment.* The site supports additional activities that the viewer can engage in that go beyond the exploration of the map. This includes adding comments and links to particular crimes, subscribing to crime data for specific areas in the city, and accessing the data programmatically. These functional characteristics considerably broaden what one can do with the data beyond the given visualization.



**Figure 2:** Home and Away juxtaposes two maps of the hometowns of fallen soldiers and the places they died [4].

**Home and Away** is a web-based visualization by CNN [4] that maps hometowns of coalition soldiers against the places in Afghanistan and Iraq where they died. The interface also features simple bar charts of casualties across age, home states, and months of death (see Fig. 2).

*Disclosure.* Besides a short introduction text, the site lacks any detailed background information and does not provide a discussion of the design decisions and intentions. The main purpose of the visualization seems to be to convey the extent of human loss on the side of the coalition forces and invite people who knew the soldiers to share their tributes and memories.

*Plurality.* Several facets are provided for exploring statistical and personal information, allowing the viewer to approach the information at different levels. The

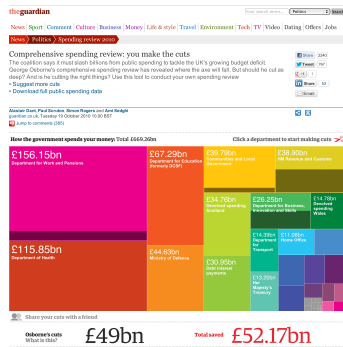
visualization focuses entirely on the coalition forces, implicitly hiding the large numbers of casualties among civilians, insurgents, and mercenaries. While soldiers of one side are given a face (literally), the many other people affected by the conflicts remain anonymous and invisible.

*Contingency.* The experience of the visualization depends on the viewer's background and ongoing changes in the represented casualties statistics. The maps as the primary representations allow the viewer to relate to the information via one's own hometown. However, relating soldiers' hometowns to a viewer's origin assumes that the viewer is from a country that is part of the coalition. While our explorations revealed only a few of such contributions, the site allows the viewer to share their emotions about the loss of people. The visualization does not allow the viewer to share their thoughts regarding the wars in general, or the hidden casualties in particular.

*Empowerment.* The ability to contribute to a visualization through comments provides a powerful mechanism to engage the viewer and shape the experiences of other viewers. However, the visualization does not provide a forum to challenge the representation, choice of data points and dimensions, or the underlying assumptions. While viewers may become emotionally engaged, there are no references to civic activities such as memorial events, troop support, or anti-war protests.

**You Make the Cuts** by The Guardian [5] shows the budget distribution across the British government using a flat treemap (see Fig. 3). The visualization, targeted at British citizens, enables selection of departments and lists individual projects for each. It starts with a short introduction to the issue of the spending review, the apparent need to reduce the budget, and invites the viewer to consider budget cuts.

*Disclosure.* The premise of the visualization is that the



**Figure 3:** You Make the Cuts allows the viewer to specify spending cuts of a national budget [5].

national budget of Britain needs to be reduced. The visualization details the exact spending figures for each governmental department. An article that is linked from the visualization explains how the 49 billion British pounds to be cut comes about. The visualization provides a link to a page with details about the underlying data.

*Plurality.* By designing the visualization as a tool to envision budget cuts, the viewer can choose a range of hypothetical outcomes leading to wide spectrum of possible representations. Given that the visualization addresses the larger issue of balancing a national budget, it is important to emphasize that the tax revenue side is not shown. Visualizing where the money for the budget is coming from, for example, along demographics, income levels, and company types, would add a particularly informative perspective. Hiding the revenue entirely from the representation creates a skewed impression of the decision space. Several other interesting aspects that could be added are more details about the services per department, the number of people who would be affected by the cuts, and the spending history over past years.

*Contingency.* By not considering the revenue side of the budget, the visualization suggests an inevitableness of budget cuts. As some commenters point out below the visualization, the implication is that a range of alternative strategies are missing, such as pursuing tax avoiders or adding funding for new areas such as green technology. Considering the ability to set spending cuts but lacking the revenue side, the visualization is paradoxically both open-ended and constrained.

*Empowerment.* At a first glance, a case can be made that the visualization is empowering as it lets the viewer use the visualization to reach beyond the present budget and imagine decisions at the national level. Furthermore, the viewer can generate custom links with their own

selection of cuts. These links can be used to have a discussion about the budget with people outside of the visualization. Commenting provides a powerful complement as viewers can have a discussion with other viewers of the visualization and the issue represented, which almost 400 people had done within the three days until commenting was disabled. However, options on what programs or how deeply to cut are highly prescribed and there is no indication of how the viewer can use gained insights for everyday decisions.

## Common Design Elements and Issues

Reflecting on examples of visualizations portraying social issues, we now discuss the employed design strategies for engaging the viewer at multiple stages, as well as some of the problems related to scoping and selection.

### Stages of Engagement

The main aim of engaging visualizations is to make a connection between the viewer and an issue. The above visualizations build these connections at different stages.

All projects included some *introduction* providing some information about intentions behind the visualization. These preambles affect disclosure and contingency of a visualization by placing it in a context and conveying a sense of 'what the issue is.' For example, the introduction to You Make the Cuts includes a brief status of the political deliberations [5]. Introductions may engage or disengage potential viewers, depending on whether the theme of the visualization is relevant to individual interests, and to the time and place of viewing [17].

To draw the viewer into a given issue, a common technique is to provide a high-level view that gives a broad perspective and helps the viewer to relate to a given issue. Using the *map as an entrance visualization* poses

such a technique that allows the viewer to link the issue to their own world. For example, a viewer of Home and Away could find fallen soldiers based on their own city [4].

Another technique to make a connection is inviting the viewer to *shape the visualization*. You Make the Cuts allows the viewer to experiment with reducing public spending by customizing their visualization [5]. Letting viewers shape a visualization based on their preferences increases a visualization's contingency, i.e., its ability to allow for a wide range of experiences. Another way viewers can shape a visualization is by leaving annotations.

When a viewer develops interest in a portrayed issue, it can be useful to *expose the underlying data* such as the crime reports accessible through Crimespotting [18]. These additional details contribute to disclosure allowing the viewer to comprehend what the representation is based on and to deepen their trust in the representation. In addition, providing the data is also an example of empowerment which allows the viewer to use the underlying data for creating alternative representations.

To make a personal connection between viewer and visualization *biographical information* lets us connect faces with numbers, as in the case for Home and Away [4]. Personal stories can increase the plurality of a visualization. As these human experiences are moving on a personal level, they can provide a powerful complement to the abstract nature of high-level visualizations.

At the later stages of engaging with a visualization it can be beneficial for a viewer to *strengthen the connection*, by regularly visiting the visualization or following the development of an issue via newsletters. This connection can also be personalized to the context of the viewer. For example, Crimespotting allows visitors to subscribe to crime reports for a certain area in the city [18].

### *Scoping and Selection*

When examining the visualizations we noted obvious patterns of unstated assumptions impacting how an issue was framed. The main framing mechanisms related to the scope of a visualization and the selection of aspects being visualized, which can be seen as rhetoric techniques [15].

Introductions are the first opportunity to frame the viewer's perception of an issue, even before seeing the visualization. While they can be very helpful, these introduction texts become the first *interpretative frames* for the visualization and by extension for the issue as a whole. For example, the preamble to Home and Away makes no mention of the enemy forces who were killed during the conflicts [4]. Would not our experience of human loss during war be different if a visualization included people on all sides?

If we consider the *larger picture*, it is striking how certain aspects can be excluded without any mention. This is particularly evident in You Make the Cuts, where leaving out the revenue side has a significant implications for the possible actions taken by the viewer [5]. One may argue that there is always a bigger picture requiring some recognition. Here the designer aiming to represent possibly controversial issues assumes an important editorial role in choosing the relevant aspects and perspectives. For a critical approach, this role requires an astute awareness of the dominant and marginal perspectives.

Abstract overviews can help understand an issue at a high level while simultaneously dehumanizing the data. Sometimes the larger story cannot be expressed only in geometric shapes, but requires the *human experience*. Crime statistics can be looked at through the lenses of time, location, and type [18]. However, the graphical techniques used may not reflect the grave nature of the

underlying issue—a visualization of crime could easily be one of coffee shop sales. To engage in a critical way, it can be helpful to bring in the voices of real people.

In the examples we examined, details about the visualization process, the provenance and quality of the underlying data, and the intentions of the creators were often lacking. In a critical practice of visualization, these details should be actively considered by the designer to establish trust between viewer, designer, and visualization.

### Open Questions and Challenges

In this section we list some open challenges for the research community and the growing communities of practice. While we do not have the space to discuss these in depth, we feel it is important to at least raise them.

While *insight* has been the primary goal of visualization research [20], making a tangible *impact* is arguably the primary goal when visualizations are deployed to engage people. As visualization moves in this direction, it becomes essential to turn a questioning lens to the tools which are shaping people's decisions. The insights a viewer gains with a visualization have real impacts on personal and political choices. The principles of disclosure and plurality largely address insight by promoting comprehensible representations, while contingency and empowerment are guiding principles towards impact through flexible interactions and empowering experiences.

Another important goal of information visualization is *making the invisible visible*. For our discussion of a critical approach, this is a particularly challenging goal. On the one hand, it resembles the aspiration of many advocacy groups to reveal concealed injustices that do not reach the surface of wider societal attention. In this sense, visualizations can empower activists to advance their issues. On the other hand, it reminds us of the multitude

of perspectives on social, political, and environmental issues. The tension between advancing an agenda and acknowledging diverse perspectives is a difficult challenge.

*Evaluation* of visualizations is a perennially difficult question; different approaches are required for different goals. In the case of critical approaches to visualization, one would want to evaluate the success of the visualization at addressing the broad goals of: (a) enabling open debate about data and (b) empowering citizens to advocate for their views using data as evidence. How can this be judged? We need to develop methods that help us to critically assess the use of engaging visualizations.

### Conclusion

In this paper, we started to outline a critical approach to information visualization. As visualizations increasingly shape people's understanding of our societies and environment, we, as a community of visualization researchers and practitioners, should reflect on and tackle issues arising from the power of information visualization. Our aim is to open the door to the active development of a critical approach for information visualization.

We have suggested the principles *disclosure*, *plurality*, *contingency*, and *empowerment* as the basis for such a critical approach. Having applied these principles as a questioning lens on engaging visualizations, we examined what a critical approach can offer. In particular, we derived a number of strategies and issues that a critical perspective brings to the fore. While the above principles are not exhaustive, we think they provide a good starting point for questioning, reflecting on, and engaging with the power of information visualization.

Critical perspectives, as evidenced in other areas and suggested in this paper, can enrich research and design. A critical approach to visualization can ultimately lead to

improvements of people's understandings of the world and subsequently to their ability to make informed decisions. As suggested by a number of research challenges, there is still much work to be done to advance critical considerations in information visualization, but we hope our contributions here represent a start in this direction.

### Acknowledgements

We would like to thank Meaghan Brierley and Uta Hinrichs for fruitful discussions about the politics of visualization and Lindsay MacDonald, Carey Williamson, Sean Lynch, and Tom Schofield for their feedback on early paper drafts. We are also very grateful to the alt.chi reviewers for their thoughtful and constructive feedback.

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