Critical Review: Exploring Interactions with Physically Dynamic Bar Charts

Introduction

Studies investigating how data can be effectively presented to, explored and interpreted by users forms the core part of Information Visualisation ('InfoVis') to support users in the decision-making process. This review summarises and critically analyses Taher et al. [2015] whose paper explores the use of physically dynamic bar chart as a device for exploring user interactions with visualisations of data, to determine future work in this domain of Information Visualisation.

Summary of Contributions

Taher et al. seeks to extend existing work on use of physical visualisations (*physicalizations*) to investigate how users interact with *physically dynamic* bar charts as a way of exploring and manipulating shape-changing datasets in the physical world. Much of the existing work reliant on use of physicalizations involve problematic *static* models that do not respond to user interactions [Jansen et al., 2013] and are therefore "*disconnected*" from the source of the data when they are created. With the advent of shape-changing technology and tangible interfaces [Rasmussen et al., 2012], there is a window of opportunity for the manufacture of physically dynamic displays to help decision makers reason about and manipulate data sets in a non-virtual and non-static way. It is this motivation that leads Taher et al. to explore the ways users interact with data displayed in this mode to understand whether physical interactions (such as touching specific data points) or gestures (such as swiping a touch-screen) or a combination of the two is more intuitive to users interacting with data visualisations in order to solve common problems.

The point system described by the article is *EMERGE* - a 10×10 set of dynamic self-actuating rods with an RGB display projected onto it (Figure 1). This system allows users to interact with the dataset it represents using a subset of 4 task-sets derived from sub-categories of the taxonomy of interactive dynamics for visual analysis described by Heer and Shneiderman [2012] - *annotation*, *filtering*, *organisation* and *navigation* (Table 1).

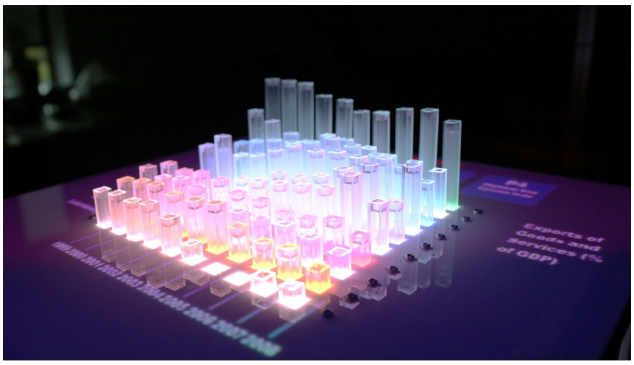

Figure 1: EMERGE: Exploring Interactions with Physically Dynamic Bar Charts using actuating physical rods and RGB LEDs to display international export data.

Table 1: Task-sets and interaction techniques explored during the user study: annotation, filtering, organisation and navigation with the

Task	**Overview**	**Interaction Techniques**
Annotation ***(Process & provenance)***	Selecting and marking individual data points.	Point, pull, press.
Filtering ***(Data view & specification)***	Hiding and refining data for enhanced perception and comparison.	Swipe away, manual press, assisted press, press shortcut, and press to compare.
Organization ***(View manipulation)***	Data arrangement by moving rows and columns.	Drag and drop with immediate transition and hide-all with transition, press with instant transition and hide-all with transition.
Navigation ***(View manipulation)***	Controlling the view of large data sets.	Scroll, directional arrows, directional press, and paging.

Heer and Shneiderman lay out 3 categories in their model - *Data and View Specification*, *View Manipulation*, and *Process and Provenance*. (Figure 2). In this sense, the choice of subcategories by Taher et al. is somewhat arbitrary and limited in their scope, but invites further research into different forms of interactions with physicalisations.

Data and View Specification	**Visualize** data by choosing visual encodings.
	Filter out data to focus on relevant items.
	Sort items to expose patterns.
	Derive values or models from source data.
View Manipulation	**Select** items to highlight, filter, or manipulate them.
	Navigate to examine high-level patterns and low-level detail.
	Coordinate views for linked, multidimensional exploration.
	Organize multiple windows and workspaces.
Process and Provenance	**Record** analysis histories for revisitation, review, and sharing.
	Annotate patterns to document findings.
	Share views and annotations to enable collaboration.
	Guide users through analysis tasks or stories.

Figure 2: EMERGE: Exploring Interactions with Physically Dynamic Bar Charts using actuating physical rods and RGB LEDs to display international export data.

The main contributions of Taher et al. [2015] is threefold. First, the authors present a set of 14 potential interactions

Justifications for Conclusions

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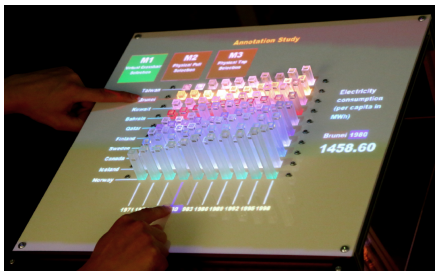

Figure 3: Annotation (Point technique).

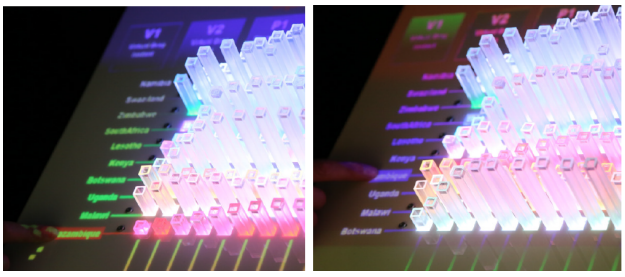

Figure 4: Organisation (Drag and Drop technique).

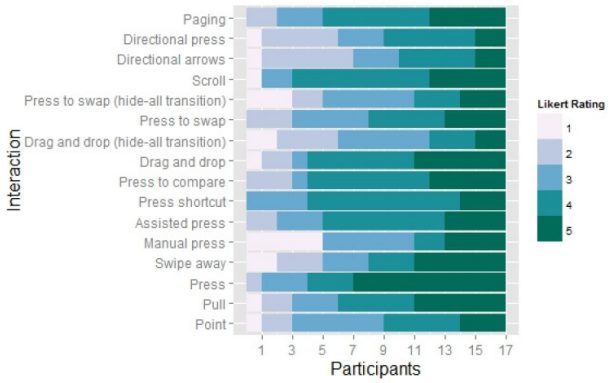

Figure 5: Likert scale ratings for helpfulness of interaction techniques. Range = 1: Strongly Disagree, 5: Strongly Agree.

Limitations and Suggested Further Work

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Conclusion

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References

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