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 critical 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 *static* models that do not respond to user interactions. With the advent of shape-changing technology, there is a window of opportunity for physically dynamic displays to help decision makers reason about and manipulate data sets.

The point system described by the article is EMERGE - a 10×10 set of dynamic actuator rods with an RGB display projected onto it (Figure 1). This system allows users to interact with the dataset it represents using four task-sets derived from the taxonomy of interactive dynamic described by Heer and Shneiderman [2012].
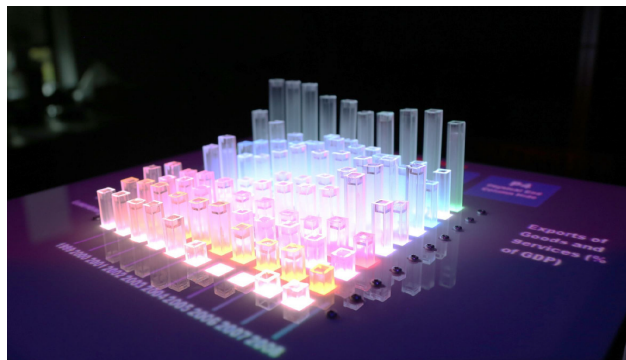

Figure 1: EMERGE: Exploring Interactions with Physically Dynamic Bar Charts using actuating physical rods and RGB LEDs to display international export data.

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: Taxonomy of interactive dynamics described by Heer and Shneiderman [2012].

Table 1: Task-sets and interaction techniques explored during the user study.

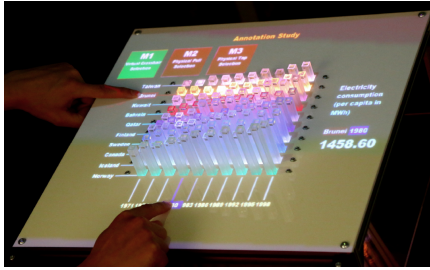| Task	Overview	Interaction Techniques
Annotation (**Process & provenance**)	Selecting and marking individual data points.	Point, pull, press.
Filtering (**Data view & specification**)	Hiding and refining data for enhanced perception and comparison.	Swipe away, manual press, assisted press, press shortcut, 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.

Justifications for Conclusions

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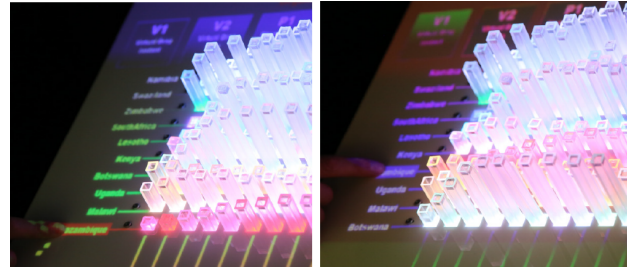Figure 3: Annotation (Point technique).

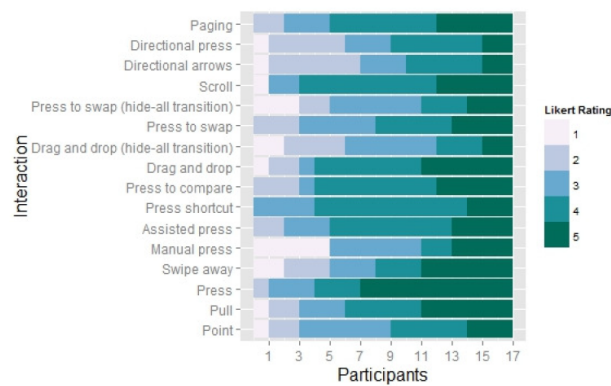Figure 4: Organisation (Drag and Drop technique).

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

Jeffrey Heer and Ben Shneiderman. Interactive dynamics for visual analysis. *Commun. ACM*, 55(4):45–54, April 2012. ISSN 0001-0782. doi: 10.1145/2133806.2133821. URL `http://doi.acm.org/10.1145/2133806.2133821`.

Faisal Taher, John Hardy, Abhijit Karnik, Christian Weichel, Yvonne Jansen, Kasper Hornbæk, and Jason Alexander. Exploring interactions with physically dynamic bar charts. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 3237–3246, New York, NY, USA, 2015. ACM. ISBN 978-1-4503-3145-6. doi: 10.1145/2702123.2702604. URL `http://doi.acm.org/10.1145/2702123.2702604`.