Projection Augmented Physical Visualizations

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ABSTRACT
Physical visualizations are an emergent area of research and appear in increasingly diverse forms. While they provide an engaging way of data exploration, they are often limited by a fixed representation and lack interactivity. In this work we discuss our early approaches and experiences in combining physical visualizations with spatial augmented reality and present an initial prototype.

Author Keywords
physical visualizations; information visualization; projection augmentation; spatial augmented reality

ACM Classification Keywords
H.5.m INFORMATION INTERFACES AND PRESENTATION (e.g., HCI): Miscellaneous

INTRODUCTION
Physical Visualizations (PV) are visualizations in which data is mapped to physical form instead of pixels [1]. Vande Moere [3] writes that PVs have the potential of sparking curiosity and turning data exploration into a fascinating experience. Spatial Augmented Reality is used to extend arbitrary physical objects with a digital layer. *Shader Lamps* by Raskar et al. [2] is a popular example in which a projector is used to augment real world objects with a texture. As most PVs are limited by fixed visual appearance, a digital augmentation seems a promising approach to minimize this constraint and provide an additional layer for interaction.

CONCEPT PHASE
The design of projection augmented physical visualizations can be split into several dimensions. The physical visualization itself is the characteristic element and its material (e.g. plastic, wood), fabrication (e.g. 3D printer, laser cutter), size and space for the projection should be taken into account. The projection can differ on the basis of its position (e.g. direct projection on the PV, projection near the PV) and its purpose (e.g. showing additional information, enabling interaction with the data). Furthermore the input modality should be considered (e.g. touching the PV, disassembling and reassembling the PV, remote input device).

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PROTOTYPE
For our initial prototype (see figure 1) an area chart as type of visualization was chosen because it offers much space for augmentation. It was built out of birch wood, as this type of wood is easily processed with a laser cutter and its bright tint is well-suited for projection augmentation. Based on web technologies 3D models for the projection and 2D vector shapes for the laser cutter were generated. The calibration process was done using mapamok[1]. The PV visualizes the export of small arms and light weapons of different countries. The projection was used to display labels and legends, to show additional data in form of stacked area charts and to provide vertical and horizontal guides to simplify comparison of different data items. Interaction, e.g. moving the guides or changing the data for the stacked area chart was done with a remote tablet device.

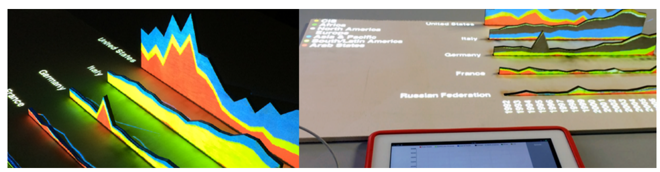

Figure 1. Projection Augmented Area Chart

CONCLUSION AND FUTURE WORK
Our exploration reveals that projection augmentation can enhance PVs. Guides for example help to overcome problems arising from perspective distortion. The augmentation of the PVs surface with additional information can compensate its static nature without losing the advantages of physical objects, which can be touched and explored with all senses [3]. As our early prototype only supports interaction using a remote tablet device the next step is to implement direct touch interaction on the PV itself. Another promising approach would be to integrate the position of the user and adapt the projection depending on their movements.

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3. Vande Moere, A. Beyond the tyranny of the pixel: Exploring the physicality of information visualization. In *Information Visualisation, 2008. IV'08*, IEEE (2008), 469–474.

[1] https://github.com/YCAMInterlab/mapamok