

mæve – An Interactive Tabletop Installation for Exploring Background Information in Exhibitions

Till Nagel¹, Larissa Pschetz¹, Moritz Stefaner¹, Matina Halkia², Boris Müller¹

¹Interaction Design Lab, University of Applied Sciences Potsdam
{nagel, larissa.pschetz, moritz.stefaner, boris.mueller}@fh-potsdam.de

²Joint Research Centre, European Commission, Ispra
matina.halkia@jrc.it

Abstract. This paper introduces the installation mæve: a novel approach to present background information in exhibitions in a highly interactive, tangible and sociable manner. Visitors can collect paper cards representing the exhibits and put them on an interactive surface to display associated concepts and relations to other works. As a result, users can explore both the unifying themes of the exhibition as well as individual characteristics of exhibits. On basis of metadata schemata developed in the MACE (Metadata for Architectural Contents in Europe) project, the system has been put to use the Architecture Biennale to display the entries to the Everyville student competition

Keywords. Metadata, visualization, concept networks, tangible interface, exhibition, user experience

1 Introduction

In exhibitions, background information is usually provided in form of audio guides with manual chapter navigation or printed materials. Current research investigates the potential of interactive systems to enhance the discovery and exploration of information in this context, for example, by looking into the possibility of augmenting objects through mobile technology and developing new software to traditional screen based systems.

This paper presents a case study of the design of the mæve installation¹. It introduces mæve, an alternative approach to make information networks behind exhibits accessible to visitors in a highly interactive, tangible and sociable manner.

The mæve system has three main components:

Each exhibit is represented in **paper cards**, which display, for example, the title, a picture and some background information of the work. These cards are produced in large amounts, and can function as take-away souvenirs or reminders of the exhibit.

¹ <http://portal.mace-project.eu/mæve/>

The paper cards can be placed on an **interactive tabletop**, whose surface displays media, texts, and metadata related to the exhibits. If several cards are placed on the table, networks of other exhibits, related projects as well as mutually shared concepts emerge. Each card combination results in a different network configuration. Position and orientation of cards constitute additional input parameters to allow the manipulation of the network visualization.

A **supplemental wall projection** displays the same information configuration as the one on the table, but with enhanced media and text displays, and reduced network complexity. It works both as an attractor for bystanders as well as a content lens for individual inspection of media presented on the table.

The information display is governed by an underlying metadata structure in the form of a **concept network**, which is based on characteristics of the exhibits. Referring to architectural exhibits, for instance, the metadata structure of *mæve* presents categories such as author, country of origin, material, functional typology, inspirational project, etc. The co-occurrences in such metadata define the visual connections among exhibits. Each card combination on the table reveals and highlights the local neighborhood defined by such configuration in the conceptual network.

As a result, users can explore both the unifying themes of the exhibition as well as individual characteristics of exhibits with an easy to use tangible system. This fosters self-paced, informal learning in a playful setting. Moreover, as it is located directly in the exhibition, and can be used by several people at a time, it affords a wide range of information and social interactions.

In the following, we discuss related work and introduce the design and technical features of *mæve*. We present a case study of how the system was used at the Venice Biennale of Architecture for the exhibition of the Everyville student competition. The paper closes with a reflection on user experience, feedback and lessons learned.

mæve has been designed and developed within the MACE² project. MACE connects digital information about architecture, and provides an infrastructure for enriching and annotating educational contents.

2 Related work

Presenting background information on exhibits has been a traditional practice among exhibitors. Over the last years, efforts have been done in order to offer alternative ways of carrying out this task. Examples are the development of interactive systems that are accessed via Web and/or presented in terminals in the exhibition location. These systems sometimes attempt to recreate the space of the exhibition through 3D models [1], or focus on grouping and presenting exhibits based on metadata [2]. Such projects, however, do not intend to integrated information in the exhibition itself.

² Metadata for Architectural Contents in Europe, <http://www.mace-project.eu>

Thus, when visitors access the information terminal, they must remember which exhibits have drawn their attention during their visit, which might be a difficult task in large events.

Another approach explores the use of mobile phones [3, 4], PDAs and RFID [5] technology to augment objects. The PhoneGuide [6], for instance, allows visitors to use their mobile phones to retrieve information. The software is installed on their phones, and recognizes when exhibits are photographed through image classification techniques. After identifying an object, it provides corresponding multimedia information. Projects with such approach have sometimes the advantage of creating collection of works tagged on-site [6], which can be later transferred to the Web and checked at home. On-site, however, they rarely establish connections among exhibits, which is useful to reinforce remembrance and to provide an overview of the exhibition.

Other projects have used interactive tables to display information on exhibits [7]. Examples are the floating.numbers [8] installation and the 2007 Graduate Exhibition of the London College of Fashion [9]. The first presents a simple click-and-view explorative interaction: hints of exhibits float over the table and open further information when touched. The second presented information as an isolated terminal would do: supporting not more than one user at the same time, and displaying not more than one exhibit or bunch of pre-defined information at each time.

3 Designing mæve

The aim of mæve is 1) to support visitors in exploring background information on exhibitions in a self-paced, playful, constructive and sociable manner, and 2) to allow users to access and discuss their own niche in the available information. We believe that the direct interaction with representations of exhibits, enhanced with information about their conceptual relations, can deepen exhibition experience and foster understanding of underlying concepts.

Designing in this area includes activities ranging from information architecture (choosing the right classification and metadata structure), interface and interaction design to algorithmic decisions (visualization model and look-and-feel), and even room setting and lighting. To investigate the complex interrelations among design decisions, technical constraints and resulting user experience in this context, we adopted an iterative prototyping approach. Firstly, interface drafts were tested and discussed in paper prototypes. The resulting coarse concept was then quickly implemented in a just-enough interactive prototype using a first table prototype in order to understand technical and interaction details. Many design decisions were only possible with this first implementation.

Visual and interface design were guided by principles of information aesthetics [10], aiming at unifying high interactivity with accurate data representation whilst adhering

to aesthetic principles in all design areas. It has been shown that data representations that are perceived as aesthetic lead to higher acceptance and lower abandonment rates [11]. Moreover, visiting an exhibition is a sensual, situated experience; in this context, the interactive installation should seamlessly blend in, and ideally establish a sensual and social experience on its own, in addition to communicating factual knowledge.

3.1 User Interaction

In this section, we present the fundamental interaction mechanisms, and describe the interface and visual characteristics of *mæve*.

The phase of collecting cards within the exhibition allows users to later explore exactly the collection of exhibits they were interested in. Each card acts as information storage and display. They not necessarily have to be used in conjunction with the interactive tabletop: with the collection of cards, visitors acquire exhibition memorabilia, and create personal collections of references of exhibits.



Fig. 1. Front and back sides of a card

The front side of each card shows a picture of the respective project, and some information such as its title, author names, and its URL (Fig. 1). A fiducial marker is printed on the backside of each card. This marker reflects an infrared light recognized by a high definition camera inside the table, which allows the system to identify the card, as well as its position and orientation. This tracking procedure was developed with *reactIVision* framework [12].

When one or several cards are put on the table, their content and metadata as well as related exhibits emerge and connect to the already displayed content, forming a network. Conceptual connections are displayed as labeled lines connecting related exhibits. Determined by factors such as the cards placed on the table, their position and rotation, the display is continuously updated in order to optimize the information density for the given configuration.

3.1.1 Placing one card

After placing a card, background information of its exhibit emerges on the interactive surface (see Fig. 2).

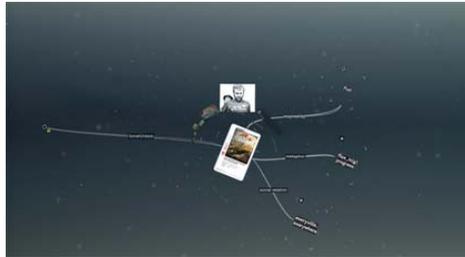


Fig. 2. Placing one card

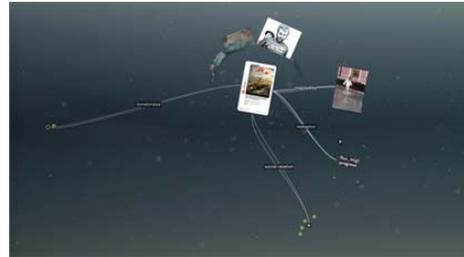


Fig. 3. Enlarging a related exhibit

Media related to its exhibit are presented through thumbnails, which are organized in a fish-eye distorted semi-circle around the physical card. The top of the card acts as a pointer “selecting” one thumbnail. Once selected, this thumbnail is enlarged on the table display and simultaneously magnified on the wall projection. In this way, users can explore the media by rotating the card towards the thumbnail they are interested in.

Related projects can be explored even if not revealed on the table by a physical card. Such exhibits exist in the network, but are initially only hinted. They can be enlarged by moving the card towards the related project (see Fig. 3). The virtual project goes through three states: from hinted, to medium-sized with title, up to full-sized with a slide show of its media files, thus revealing more information each step.

3.1.2 Placing multiple cards

When multiple cards are placed on the table, relations among the exhibits, as well as further related projects appear (see Fig. 4 and 5).



Fig. 4. Placing two cards

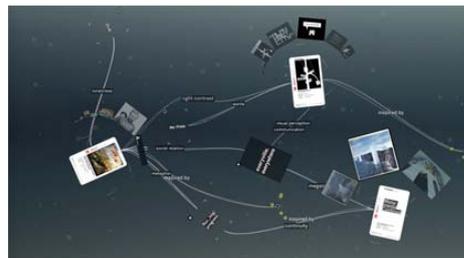


Fig. 5. Placing multiple cards

Depending on the number of cards placed on the table, the set of relations shown might be reduced to a subset. In order to reduce complexity, only the most important relations are displayed. The importance of a relation is computed based on the shared metadata, which are weighted according to their relevance to each single exhibit. Furthermore, the emerging structure depends not only on the kinds of cards placed simultaneously, but also on the order they are placed: the system prioritizes the

establishment of relations to already visible projects. This makes the comparison of new and previous configurations easier – comparison that would demand more effort from the user if larger parts of the network changed.

As more cards are placed on the table, the number of relations increases and display items are more likely to interfere visually. To minimize visually distracting line crossings, we implemented a path finding algorithm: The lines follow smooth curves to the related object, while avoiding obstacles such as other physical cards, or virtual projects in full-size. The control points of the continuous Bézier spline are prevented to collide with an obstacle by its repulsion force, thus resulting in smooth obstacle avoidance. For the remaining, unavoidable crossings, we introduced a spatial metaphor in order to reduce visual clutter: through changes in transparency, one of the lines appears to go underneath the other one.

3.2 Social interaction

The large tabletop as well as the overall spatial setup support interaction by multiple visitors at the same time. Accordingly, the installation induces not only human-computer, but also human-human interaction in manifold ways. As Stanton et al. suggested [13], a large interaction area stimulates or even enforces collaboration since one single user is not able to manipulate all objects.

Users are not isolated in a terminal accessing information of individual interest. In mæve, their interests are shared and may overlap. We observed a variety of ways in which visitors got in touch with each other via the table, e.g. discussing the displayed information, asking for more space or a distant card, or simply co-creating interesting networks. This collective activity promotes even more remembrance of exhibits [14].

4 Case study: Mæve at Architecture Biennale

The mæve system has been put at use on the occasion of the Everyville student competition of the 11th Biennale of Architecture in Venice. A fully working system has been implemented, using the reacTIVision framework for card tracking and the Processing [15] language for the visualization front-end.

The installation provided background information for the selected entries of the competition. The entries have been presented with general data such as title, authors, location, and descriptive texts, as well as with the submitted images and additional media. Furthermore, we asked the winning groups to name inspirational projects, which we incorporated to deepen the understanding of the idea and concept of the original entry.

To form the conceptual network and to be able to create meaningful connections the projects were classified by terms from the architectural and engineering taxonomy of the MACE Application Profile [16]. This taxonomy was designed to meet the specific

information needs in architecture, and to support the semantic description of architectural and design projects.

In addition, authors of exhibits chose freeform terms they judged appropriate to describe their works. These terms, however, have been unified into the taxonomy before being integrated into the database. Experts of the architectural domain set and adjusted the terms and their importance (weight) according to how characteristic and specific it was for each project.



Fig. 6. Setup at Arsenale, Venice



Fig. 7. Visitors using the installation

The spatial arrangement and the light setup were defined with the objective of guiding visitors through the installation, while inviting them to watch and participate. The table was located in the middle of the exhibition room (Fig. 6), backed by the main wall projection, which immediately grasped the visitors' attention.

The implemented interactive surface had an area of 1.87 m². In order to guarantee visible access to the wall projection, the side of the table that directly faced the projection was subtly obstructed: on this side the table was lengthened with a non-interactive surface, which served as a display for the cards.

The total dimension of the table was 2.2 m x 1.7 m x 1.0 m. The height of 1.0 m was necessary to allow the inner projection to reach the surface after being reflected by two mirrors. It also turned out to be optimal to allow access of standing users (Fig. 7).

The resolution of the interactive screen was 29.4 pixels per inch (full HD 1080p). As resolution strongly influences visualizations [17], this relatively low resolution led us to iteratively re-design the interface, by testing different font faces and sizes to improve readability and by adapting animations and the overall design.

The spatial setup in combination with the chosen interface design allowed an “upwards” interaction metaphor; when cards were placed on the table, background information arose from the “bottom” of the table, floating in the surface, and ending up by being projected on the wall.

5 User experience

During the weeks *mæve* was presented at the Biennale, we had the opportunity to receive feedback from users and to observe them engaging in the exhibition. Overall, the interaction turned out to be very intuitive. Users affirmed that it took a “fraction of second” to understand the connection between cards and screens, however, the use of the table and function of graphics was reported to demand more time, being mostly understood after the first try. Some visitors attempted to directly manipulate the displayed objects, as if they were using a multi-touch table [18]. Others initially placed the card with the front side facing the table, obtaining no feedback.

Many people were attracted by curiosity, but even those who failed to grasp the multiple levels of the installation used the opportunity to play a game of cards. We noticed that users generally spent more time engaged in the installation when more than one person was present. In fact we witnessed situations in which groups of university students, amounting to up to 60 young persons, were able to place at least one card each, spending long periods of time exploring and discussing the information provided by the system.

During students’ visits it was also possible to realize the potential of *mæve* to be used as a teaching tool. The intricate web of concepts, elements and dependencies presented to the reader in the condensed visualizations has served as an object for both playing and extensive analysis, bringing up a diverse combination of concepts involved in architectural practices. This analysis benefited from the fact that this network of entities was entirely at the user’s control. While perusing theoretical concepts like distance and memory, form and identity, the act of card-playing underlined the ludic aspects of architecture and exhibitions.

Lessons learned

During the conception and development of *mæve* we experienced that the design of such an interactive system presents special challenges: card turning as an input action, or the absence of the traditional top-bottom screen orientation (as the table can be used from different sides) open space for innovation in user interface design. Another critical aspect is the interplay of the visualization with the data and information basis on the one hand, and the spatial setup and situation on the other hand.

The physical component of the installation imposes its own limits: we were not able, for example, to find a satisfactory treatment for the case in which multiple instances of the same card were placed on the table. Thus, links to cards placed were lost when another instance of the same card was put on the table. However, we observed users turning this “fault” into a playful feature, by purposefully placing many instances of the same card in order to claim the link to the network of concepts. This example demonstrates the social function of *mæve* as a facilitator of human-human interaction between strangers, and points out to the importance of the social aspect in shared interactive displays.

6 Conclusion

Mæve shows a way of providing new browsing experience by combining tangible interaction, complex visualization and collaborative data examination. By inspecting conceptual relations on the table, visitors can find other significant works, or understand how their interests connect to information shared between exhibits. The simplicity of placing a card on the table imposes a low barrier to start interacting with the system. The visualization aesthetics and feedback invites users to explore both interaction mechanisms and displayed information without demanding great amount of concentration. In addition, the installation makes spectators aware of how metadata can be utilized to interconnect knowledge resources, and how the overall understanding benefits from these connections.

7 Acknowledgments

The mæve installation was created by Tina Deiml-Seibt, Steffen Fiedler, Jonas Loh, Thomas Ness, Stephan Thiel, and the authors, members of the Interaction Design Team of the University of Applied Sciences Potsdam.

This project was co-funded under contract number ECP 2005 EDU 038098 in the eContentplus programme in the context of the MACE project. The interactive table was kindly supported by Werk5 GmbH.

We would like to thank Furio Barzon and Matteo Zambelli for their professional and organizational support, and Massimiliano Condotta, Elisa Dalla Vecchia, Elena Orzali, and Vittorio Spigai for contributing their expertise to creating a meaningful and understandable network of architectural contents, and for their efforts in classifying the material. Furthermore, we would like to thank all MACE partners for their support and ideas. Last but not least, we also thank La Biennale di Venezia, Telecom Italia, and all students who participated in the Everyville competition.

References

1. Mourkoussis, N., White, M., Patel, M., Chmielewski, J., and Walczak, K.: AMS: metadata for cultural exhibitions using virtual reality. In: Proceedings of the 2003 international Conference on Dublin Core and Metadata Applications: Supporting Communities of Discourse and Practice Metadata Research & Applications (Seattle, Washington, September 28 - October 02, 2003), pp 1-10, Dublin Core Metadata Initiative (2003)
2. Yee, K., Swearingen, K., Li, K., and Hearst, M.: Faceted metadata for image search and browsing. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Ft. Lauderdale, Florida, USA, April 05 - 10, 2003) CHI '03, pp. 401-408, ACM, New York, NY (2003)
3. Mäkelä, K., Belt, S., Greenblatt, D., and Häkkinen, J.: Mobile interaction with visual and RFID tags: a field study on user perceptions. In: Proceedings of the SIGCHI Conference on

- Human Factors in Computing Systems (San Jose, California, USA, April 28 - May 03, 2007). CHI '07. ,pp. 991-994. ACM, New York, NY (2007)
4. Roussos, G., Marsh, A. J., and Maglavera, S.: Enabling Pervasive Computing with Smart Phones. In: IEEE Pervasive Computing 4, 2, pp. 20-27. IEEE, Zurich, Switzerland (Apr. 2005)
 5. Hsi, S. and Fait, H.: RFID enhances visitors' museum experience at the Exploratorium. In: Communications, pp. 60-65. ACM 48, 9 (Sep. 2005)
 6. Bruns, E., Brombach, B., Zeidler, T. and Bimber, O.: Enabling Mobile Phones To Support Large-Scale Museum Guidance. In: IEEE Multimedia, vol. 14, no. 2, pp. 16-25. (2007)
 7. Geller, T.: Interactive Tabletop Exhibits in Museums and Galleries. In: IEEE Comput. Graph. Appl. 26, 5, ,pp. 991-994. IEEE, Zurich, Switzerland (Sep. 2006)
 8. Art+Com: floating.numbers installation, <http://www.artcom.de>
 9. 2007 Graduate Exhibition of the London College of Fashion, <http://www.fashion.arts.ac.uk/37189.htm>
 10. Lau A. and Vande Moere A.: Towards a Model of Information Aesthetic Visualization, In: IEEE International Conference on Information Visualisation (IV'07), pp. 87-92. IEEE, Zurich, Switzerland (2007)
 11. Cawthon N. and Vande Moere A.: The Effect of Aesthetic on the Usability of Data Visualization, In: IEEE International Conference on Information Visualisation (IV'07), pp. 637-648. IEEE, Zurich , Switzerland (2007)
 12. Kaltenbrunner, M. and Bencina, R.: reacTIVision: a computer-vision framework for table-based tangible interaction. In: Proceedings of the 1st international Conference on Tangible and Embedded interaction (Baton Rouge, Louisiana, February 15 - 17, 2007), TEI '07, pp. 69-74. ACM, New York, NY (2007)
 13. Stanton, D., Bayon, V., Neale, H., Ghali, A., Benford, S., Cobb, S., Ingram, R., O'Malley, C., Wilson, J., and Pridmore, T.: Classroom collaboration in the design of tangible interfaces for storytelling. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Seattle, Washington, United States), CHI '01, pp 482-489. ACM, New York, NY (2001)
 14. Rajaram, S. and Pereira-Pasarin, L.: Collaboration can improve individual recognition memory: Evidence from immediate and delayed tests, In: Psychonomic Bulletin & Review, vol. 14, no1, pp. 95-100. Psychonomic Society, Austin, Texas, USA (2007)
 15. Processing website, <http://www.processing.org/>
 16. Stefaner, M., Spigai, V., Vecchia, E.D., Condotta, M., Ternier, S., Wolpers, M., Apelt, S., Specht, M., Nagel, T. and Duval, E.: MACE: Connecting and Enriching Repositories for Architectural Learning. In: Browsing Architecture: Metadata and Beyond : International Conference on Online Repositories in Architecture (Venice, Italy 20 -21 Sept. 2008), pp.22-49. Fraunhofer IRB Verlag, Stuttgart (2008)
 17. Isenberg, P. and Carpendale, S.: Interactive Tree Comparison for Co-located Collaborative Information Visualization. In: IEEE Transactions on Visualization and Computer Graphics 13, 6, pp. 1232-1239. . IEEE, Zurich, Switzerland (Nov. 2007)
 18. Rekimoto, J.: SmartSkin: an infrastructure for freehand manipulation on interactive surfaces. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Changing Our World, Changing Ourselves (Minneapolis, Minnesota, USA, April 20 - 25, 2002), pp. 113-120. CHI '02. ACM, New York, NY (2002)