The Card Box at Hand: Exploring the Potentials of a Paper-Based Tangible Interface for Education and Research in Art History

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ABSTRACT
This paper presents art historical research and education as a novel application area for tangible user interfaces. The academic discipline of art history and its subjects are currently undergoing changes that will lead to a rising importance of computers. However, the computer is generally not the art historian's tool of choice. We feel that this is due to existing GUI systems not fully meeting researchers' needs. We therefore propose a design for a tabletop tangible user interface considering art historians' desire "to collect things as tokens" [1] and to remain within traditional techniques. We present a case study of the usage of image cards within iconographic work. Based on our results, we derive implications for the design of the tangible interface that integrates approved traditional paper based techniques with the advantages of digital representation.

Author Keywords:
tabletop tangible interface, paper card interface, digital art history, creativity support tool, information visualization.

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H.5.2 [Information Interfaces and Presentation]: User Interfaces – *input devices and strategies, interaction styles, user-centered design*.

INTRODUCTION
With the help of ever advancing technologies, computing is moving beyond the desktop, enabling users to interact with computer applications in new ways. One of the emerging new technologies are tangible interfaces which link physical objects to digital information [5]. While GUI design focuses on the digital aspects, TUI design also includes the physical aspects of the interface and, moreover, finding a fruitful balance between the two parts. These hybrid systems present great opportunities to combine the users natural environment and their traditional techniques with the advantages of computer systems.

In this paper, we present a case study about art historical work techniques as a starting point for a paper-based tangible interface for education and research in art history. Art historians have a strong tradition in working with card boxes and image cards made of paper. Concurrently, a trend towards a *digital art history* exists [9]. Nevertheless, art historians' threshold to use computer-based tools remains high and many still prefer their traditional tools. Our approach aims to make the computer a more powerful and accepted tool for art historians by integrating the traditional way of working with paper cards into a tabletop tangible interface. We briefly describe related work on paper-digital integration and interactive tables. Then, we discuss our findings on art historians' ways of working, both general and by observation of a real project. From this we derive implications for a possible tangible user interface to support their work. Finally, we outline a potential design of the resulting application.

BACKGROUND

Paper-Digital Integration
An important theme within HCI is the integration of paper- and computer-based work. Wellner's "Digital Desk" [13] marks an early attempt to integrate the real desk into computer applications using augmented reality. Mackay et al. developed different systems with interactive paper [7]; among these was an augmented paper storyboard for video producers. Another physically embodied interface, presented by Nelson et al., is "Palette" [8], which employs paper cards with barcodes as physical handles for electronic slide shows. To improve the understanding of peoples' usage of paper and computers, Sellen and Harper conducted an analysis involving office workers and discovered many useful affordances of paper [10].

Interactive Tables
Interactive tables are often included in visions of "the workspace of the future", aiming for a better support of

collaborative work with digital data. An example table project is the Shared Design Space [4]. It provides beamer projections onto the tabletop and utilizes Anoto® pens for digital writing. Other examples of interactive tables are developed for multi-person social settings and storytelling, such as the Personal Digital Historian [11]. Furthermore, music application tables are quite popular. On example is the ReacTable* [6], an interactive music instrument with a tabletop tangible user interface, where users control the sound synthesizer by moving real objects with markers on the table surface.

Art History Work Methods

The academic discipline of art history studies and interprets works of art, traditionally including paintings, sculpture, architecture, and arts-and-crafts. As, in most cases, the original pieces of art are not available, photographic reproductions are of major importance. Furthermore, these images offer good opportunities for comparison and detail-viewing. In fact, the investigation of the content of images constitutes a crucial part of the work. The method of iconography, which literally translates to "image writing", deals with the identification, description, and interpretation of single motifs of images and consequently their relation to relevant text sources. Our focus in this paper is on the field of political iconography. Within this methodical approach, images are interpreted as elements of political communication.

AN ANALYSIS OF ART HISTORY WORK

To establish a basis for the design of a tangible interface we conducted an ethnographically inspired analysis of the application domain, focusing on the media and techniques used in this area. As one of the authors studied art history and still works with art historians, she gained first hand experiences over a period of seven years. As part of our analysis, she observed art historians' work practices during two digital art history seminars and conducted in situ-interviews with the academic staff. Moreover, she interviewed three graduates about their research in the context of their theses projects.

In the first part of the analysis, our aim was to clarify basic principles of art historical work. We learned about traditional techniques and observed an example of a new computer-based tool for art historians. In the second part, we explored in an example art history research project to discover the goals, the problems, and the needs of the researcher.

General Findings

In the context of our analysis, the following general observations were made:

- Art historical interpretation, especially iconographic analysis, includes the close work with many images. Common tasks are identification, comparison, and classification of image motifs and finding relations between them.
- Art history is a hermeneutic discipline. The process and method of interpretation is not given, but is chosen individually, dependent on the research question and the personal background of the researcher. Art historian work is creative work.
- Art historians work alone or in small teams, usually sitting around tables.
- An important tool for iconographic work is the card box, which we will discuss in more depth below.

Working with Card Boxes in the Tradition of Warburg

The usage of card boxes has been a widely spread technique among scientists within the humanities for several centuries. In contrast to linear-structured books with limited editing capacity, card boxes offer a way to store information in an open and flexible structure and enable the creation of new and rearranged dispositions. Information is stored, in an 'atomized' form, on paper cards and arranged by keywords. Its convenient size and its lightweight, simple, and cheap material make the paper card a popular utility.

An important art historian and one of the founders of modern art history, who used the card box principle intensely, was Aby Warburg (1866 – 1929) [3]. Today, Warburgs work is well noticed even outside art history, as he was concerned with problems of visualization and representation of complex semantic structures [2]. As well as books, he used clusters of photographs, self made diagrams and stacks of index cards to find and store semantic relationships. Especially noteworthy is his usage of the collage. For visualization, he pinned clusters of photographs on big black canvases that enabled him to compare motifs, to explore relationships between details in different pictures, and to make contexts explicit. As the photographs where only pinned, arrangements could easily be changed, making the canvas a perfect tool for the process of scientific work. Hence, Warburg used card boxes as individual tools for visualizing and thinking. Furthermore, he brought the canvases as presentation media to talks and used them as layout for the publication of a picture atlas.

Computer Support in Digital Art History

The discipline of art history has been developing computer-supported applications specific to art historians' needs. These are, among others, networked image databases, e-learning applications, and content-management systems. Given the fact that the discipline's subjects have moved beyond traditional forms of art to video, media art or virtual reality, the benefit of the computer is likely to increase [9]. Although discipline specific applications exist, these are not widely used within art history education.

The Warburg Electronic Library (WEL) [1] is a prime example application developed for art history usage. This web-based image database contains digital copies of indexed paper-based image. To simplify the usage and to increase the acceptance of the new tool, the developers transfered well-known concepts of image cards into GUI metaphors. The WEL-System was used in the observed seminars, in which students worked with the electronic library to search for pictures and to collect relevant material for their project. The final task for the students was to compose a website about their results containing an image collage and text. We observed that, to create the collage, the students printed the images to have the material at hand. The GUI interface offered keywords to classify and structure the material, but images were still listed linearly and could not be moved around on the screen.

An Exemplary Art Historical Project

To gain insights into specific requirements, we analyzed a thesis project as an exemplary case. The chosen project was a 6-month-lasting thesis about the iconography of German soldiers in World War I, written by a student of history and art history. In this section, we present the results from an interview and from document viewing. The researcher's task was to investigate continuity and change within the illustrations and to relate this to questions within cultural science. She applied the method of political iconography.

As our aim is to support a creative process, it is helpful to identify different stages within the process. Ben Shneiderman has introduced four stages of activity that form the creative process [12]. We found these steps being applied in the analyzed project:

Collect: First, the student had to search for relevant image sources. She chose illustrations taken from a journal about popular prints publicized between 1914 and 1920. She digitized the image material and stored the 220 illustrations as files in folders on her computer.

Relate: Throughout the whole process, she showed the illustrations to friends, fellow students, and professors to discuss her questions.

Create: The create stage marked the biggest part of the work. The classification of the motifs in the 220 illustrations turned out to be quite complicated, especially until they only existed as digital image files on the computer. The student soon realized that the screen did not offer the spatial opportunities she needed to classify the motifs. Thus, she printed the illustrations on paper and stored the printouts in a card box, offering a mobile and manageable collection of all the image material. She enjoyed the intense work with the cards, spread them out on tables, made piles of cards with similar motifs, and temporarily linked them together with elastic band. The backs of the cards were used for annotations and stampings. She stated that spreading the cards on the table delivered crucial insights. The ease of rearrangement and flexible grouping by elastic band made them essential tools for creative work in progress. Additionally, she noted her results in tables and diagrams.

Donate: During the final stage of her research work, she created image collages containing the illustrations grouped by motifs. They were published as part of her thesis. She was also able to use transparency prints of the image collages for a talk about her work.

A TUI'S POTENTIALS FOR ART HISTORICAL USAGE

Our observations have shown that, on the one hand, paper based tools are crucial for the creative process of art historical work. On the other hand, computer applications are powerful digital tools for tasks such as image search in databases, building a personal archive, managing complex structures, and communicating about items. In our analysis, we identified the following potentials of a tangible user interface for art historians:

- TUIs enable the integration of digital tools into the traditional paper based work.

Paper cards can be used either offline or as physical handles of a computer application, which remains in the background. TUIs can reduce the art historian's mental load in using the computer and make it a more accepted tool within cultural sciences.

- The integration of TUIs into established GUI-applications is of major value.

Tangible interfaces are well suited for exploring and visualizing tasks; but many other tasks are hard to accomplish with tangibles. We consider the combination of the advantages of their physical representation with the power of conventional digital representations a big potential. In art historic work, the “collect” and “donate” activities are best supported by GUI-applications (e.g. web based image databases, text editing software, and presentation applications), while a TUI could offer good support for “relate” and “create” activities (see next item). This means that import and export functions for data interoperability are necessary.

- TUIs offer good support for “relate” and “create” activities.

As TUIs are good tools for externalization, they can support the discussion of ideas in small groups. They facilitate the work with images at the “create” stage, offering visualization aids and functions for classification, comparison, detail zooming, storing, and associations.

- A paper-based TUI is well suited for the work with a personal pre-selected material collection.

As paper cards are easy to create, users can link their own handles to digital information. Of course, this only works, if

the amount of items is manageable. This is usually the case within art historian research tasks. The printed cards enable close work with the research material.

- TUIs offer physical handles to different media.

The integration of new media subjects into academic art history both offers further potential and poses a challenge. Work in genres such as film, media art or virtual reality is more and more becoming the subject of the discipline's analysis. Consequently, a TUI should also offer physical handles to objects of new media.

Potential Design of the Tangible User Interface

In this section, we outline a potential setup for a tangible user interface (see Figure 1), which was already approved by art historians using paper prototypes. This tangible user interface for art historians will be a tabletop system enabling spatial work on the table surface. A semi-transparent area of 60 to 40 cm will be reserved for the work with the image cards. As the cards will need to be tracked and identified by the system, they will have fiducials on their back, which a camera positioned below the table will identify. Nevertheless, they also allow normal annotations and can be used offline. Part of the interaction area could consist of dedicated fields to call functions such as "zoom", "save collages", or "show annotations" by placing cards into these areas. Graphical feedback to tangible interactions will be projected directly onto the interaction area, while complete image collages, image zooms, or annotation information will be shown in a separate field for graphical representation next to it. A projector will be located above the table. If the paper cards are handles in a consistent manner, created collages can be saved and printed as image cards. The user can carry on interrupted work and update collages by loading these collage image cards and putting the relevant single cards back onto the surface. Additionally, for text editing and further processing, standard input devices will be provided.

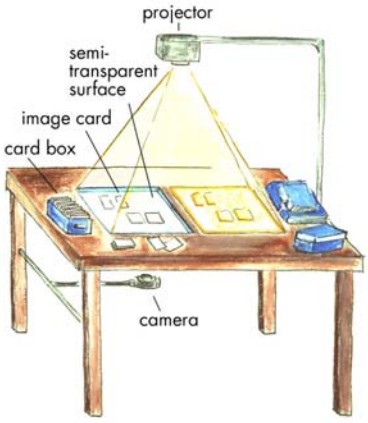

Figure 1. Setup of the Tangible Interface.

CONCLUSIONS AND FUTURE WORK

In this paper, we have presented a case study about art historians' work techniques. Based on our case study we derived design guidelines for a TUI to support art historians to focus on their creative tasks and to work with their approved tools, their "card boxes at hand", while the computer keeps track of their work and offers further resources. The "create" and "relate" activities are well supported by this type of interface. The design has already been approved through its paper prototypes. Our next step is to build the tabletop system and the applications featuring the identified support tools. We will then formally evaluate the application and use of the complete system.

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